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The Legionary Ants of the United States Belonging to Eciton Subgenus Neivamyrmex Borgmeier

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Introduction

Although this paper is primarily a taxonomic review of the 17 forms of legionary ants comprising the subgenus *Neivamyrmex* of the United States, an effort has been made to include the known facts pertaining to their distribution and biology. Our knowledge is very meager, however, owing to the primitive nature of the ants, their subterranean habits, and secretive disposition. There is no reason to doubt that future collecting will result in the discovery of new forms, especially in the Southwestern States; and probably some names now treated as valid will need to be suppressed as synonyms when the various castes of each species have been correctly associated. It is hoped that this review may result in attracting more attention to these interesting but little-known ants and in stimulating observations on their habits and biology.

The legionary ants are of Neotropical origin, and most of the species occurring in the United States are found in the region from Texas westward through New Mexico and Arizona into the southern half of California. The exact distribution of the various species cannot be accurately outlined at present because of our lack of knowledge of the different forms and their associated castes. Reference to the map (Fig. 1) will show that only four species occur in the area east of the Mississippi River, and apparently only one of these extends as far north along the Atlantic seaboard as Norfolk, Va. *Eciton (Neivamyrmex) nigrescens* is the most widely distributed legionary ant, ranging northward in the Mississippi Valley region to Sioux City, Iowa, and thence westward through Nebraska and Colorado into the southern half of California. Other species, however, have been found as far north as Palo Alto and Sacramento in California and may occur even farther north.

Some species have been collected at altitudes ranging from sea level to as high as 6,000-8,000 feet. Strictly speaking, these are not mountain forms, however. They seem to prefer to nest at elevations of 2,000 feet or less. Those that occur above this altitude are apparently found only in canyons and valleys or on plateaus and never on the higher and more precipitous mountain slopes.

The nests which I have observed have usually been in rotten logs and stumps or in the soil beneath objects lying on the surface of the ground.

Occasionally the ants are found in buildings, where they seem to be nesting, foraging, or bivouacking in or around basement foundations. The colonies of some species, such as *nigrescens*, may contain many thousands of immature individuals and workers, a single female, and, at certain periods of the year, numerous males. The males of many species apparently do not remain long in the nest. Some are attracted to artificial lights at night and are often captured there by collectors. Male pupae are borne in cocoons; worker pupae, apparently never. No one, so far as I am aware, has ever observed the transformation of a female. Information is lacking as to the number of virgin females simultaneously produced in a colony and also as to whether a virgin female is fertilized by a brother male or by a male from another colony. In May 1932, D. E. Read found a mating pair of *carolinense* in a nest at Spartanburg, S. C. Apparently this is the first record of such an observation on legionary ants in the United States. From the available evidence, which is too meager to be very conclusive, I am inclined to believe that mating often takes place in the same nest between brother and sister. This, of course, does not preclude the mating of sexes of different colonies. Although fertilized females of many primitive ants may establish new colonies unaided by workers, I believe this does not occur with the legionary ants, the female of which seems to be less independent than the females of other primitive ants. A new colony is perhaps formed by a recently fertilized female migrating from the parental

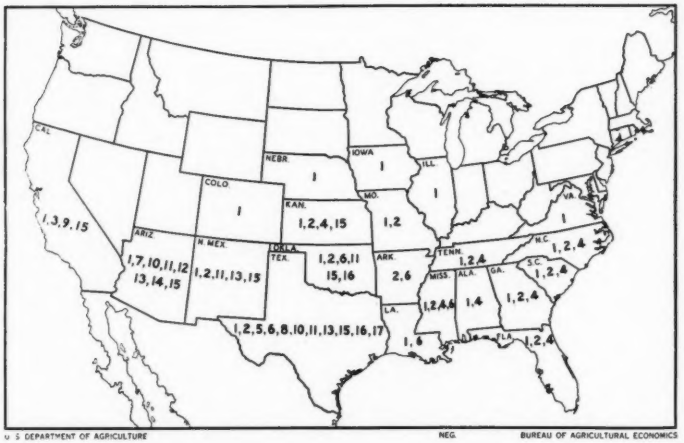


Fig. 1.—Distribution of legionary ants, *Eciton (Neivamyrmex)*, in the United States. No. 1=*nigrescens* (Cresson); No. 2=*opacithorax* Emery; No. 3=*californicum* Mayr; No. 4=*carolinense* Emery; No. 5=*wheeleri* Emery; No. 6=*pilosum* F. Smith; No. 7=*melanocephalum* Emery; No. 8=*pauxillum* Wheeler; No. 9=*leonardi* Wheeler; No. 10=*commutatum* Emery; No. 11=*harrisii* (Haldeman); No. 12=*pilosum mandibulare*, new subspecies; No. 13=*arizonense* Wheeler; No. 14=*oslari* Wheeler; No. 15=*minus* (Cresson); No. 16=*melsheimeri* (Haldeman); No. 17=*fuscipennis* Wheeler.

colony accompanied by a detachment of sister workers. This may take place at night or beneath the surface of the soil.

As far as known, these ants are carnivorous, their food consisting largely, if not entirely, of insects. *E. (N.) nigrescens* has been observed (Smith, 1927) preying on termites, adult ants, and carabid beetles. The brood of other ants seems to be a favorite food.

Although some species are probably entirely subterranean, others, such as *opacithorax, pilosum,* and *nigrescens,* are not strictly so. The workers of these species are commonly observed trailing over the ground, even in full sunlight, and are sometimes accompanied by their myrmecophiles, such as staphylinids and phorids. These processions seem to be mostly for foraging purposes. I have never seen a male or a female in any of them and am inclined to believe that when the ants change their nesting site the female must migrate at dusk or at night.

There is a great deal of confusion in regard to the taxonomy of the legionary ants due to the loss of types, incorrect citation of type localities, inadequate descriptions, misdeterminations, and, especially, failure to associate the various castes of certain species. Some species are known only from males, other species only from workers. Until all castes of a given species can be correctly associated by collection from the same nest it will be impossible to determine the synonymy that may be involved. To emphasize the striking dissimilarity between castes of a species it should be mentioned that the male and female have a single-segmented petiole whereas the worker has a two-segmented petiole; the male has large eyes and ocelli, the female and worker small eyes and no ocelli; the male is always winged, the female never. There are also striking differences between the polymorphic workers of a single species, these being so marked that it is sometimes difficult to associate minor workers and major workers correctly. In this paper the keys and descriptions are based on the major workers, as this is the most easily recognized caste of the polymorphic workers.

Anyone who has undertaken an intensive study of the legionary ants must be impressed by the great amount of intraspecific variation. To illustrate, the male of *pilosum* is easily recognized by the shape of its mandibles and body, by its general color, and by the nature of the pilosity. Yet when numerous specimens from various localities are studied, it is noted that some normally good characters are very inconstant. Such characters relate to the degree of development of the protuberance or toothlike angularity on the superior border of the mandible, the size and convexity of the eye, the width of the space between the frontal carinae, the distance between the inner border of the eye and the lateral ocellus, the depth of the body color, and the length of the pilosity. An attempt has therefore been made to point out all the noticeable variation among the different castes of the various species as far as material at hand would permit.

Specimens have been received for study from a number of California

localities, including Los Angeles, Davis, La Verne, and Paraiso Springs. The individuals from each of these localities vary considerably, but all agree in belonging to what may be designated as the *nigrescens* complex, as evidenced by the shape of the mandibles, petiole, and postpetiole, and by the general nature of the sculpturing and pilosity of the worker. The characteristics of the specimens from each locality are too elusive to be satisfactorily described or used in a key, and it appears unwise to attempt to decide on the taxonomic status of these ants until all castes of each form are known or until more intensive collecting has brought to light new or related forms which may aid in clearing up the confusion in this complex.

The specimens were studied under an electric light (alternating current and a 6 CP bulb) with a binocular microscope. The effect of varying light intensities even under these conditions is such that the sculpturing, pilosity, and color of a specimen do not always appear the same. Care was taken in making measurements to select the greatest breadth or the greatest length of the part of the body under consideration. The measurments of the head, however, do not include the mandibles. In citing the distribution of the various species I have purposely listed some localities outside the United States in order to show the wide range of the ants. No effort, however, has been made to study a large number of specimens beyond the borders of the United States.

The illustrations for this article were made by Mrs. Sara H. DeBord.

SOURCES OF MATERIAL

This study is based on specimens from the following institutions and individuals:

American Museum of Natural History, Museum of Comparative Zoology, United States National Museum, Los Angeles County Museum of History, Science, and Art, Academy of Natural Sciences of Philadelphia, University of Minnesota, University of Oklahoma, University of Nebraska, University of Texas, University of Arizona, University of Kansas, University of Louisiana, Southwestern University of Louisiana, Emory University, Mississippi State College, Kansas State College, Texas Agricultural and Mechanical College, Pomona College, North Carolina State Department of Agriculture, Illinois State Natural History Survey, Dr. A. C. Cole, Jr., Dr. W. S. Creighton, Dr. W. M. Mann, Dr. Mary Talbot, Mr. Arnold Mallis, Mr. R. H. Baker, Mr. L. G. Wesson, Jr., Mr. Wm. F. Buren, Mr. P. H. Timberlake, Mr. J. E. Gillaspy, Mr. H. H. Keifer, Mr. V. E. Williams, and Mr. R. W. Strandtmann.

TERMINOLOGY

With few exceptions, the descriptive terms used in this paper are those commonly employed by formicologists. There are some, however, which should be explained to avoid confusion. For instance, when the mandible is of a triangular shape, the three borders are designated as the inferior, superior, and masticatory. If the masticatory border is absent or ill defined, then the two remaining borders are the inferior and superior borders. In referring to parts at the tip of the gaster of the male I have followed Snodgrass's terminology of the male genitalia of Hymenoptera (Snodgrass, 1941). His terms and their equivalents as generally used by formicologists follow:

Snodgrass	Formicologists
ninth abdominal sternum (seventh gastric)	hypopygium, subgenital plate
eighth abdominal tergum (sixth gastric)	pygidium
paramere	stipes
volsella	volsella
aedaegus	penis

In the female, what formicologists usually call the hypopygium and pygidium would be designated by Snodgrass, respectively, as the seventh abdominal sternum (fifth gastric segment) and seventh abdominal tergum (fifth gastric segment). These latter terms are employed in the present paper.

ECITON, subgenus NEIVAMYRMEX Borgmeier

Labidus Jurine (part) Shuckard, 1840, Ann. Nat. Hist. **5**:196.
Eciton Latreile (part) Fred. Smith, 1855, Trans. Ent. Soc. London **3**:160.
Acamatus Emery, 1894, Bull. Soc. Ent. Ital. **26**:181.
Leptanilla Holmgren (not Emery), 1908, Zool. Anz. **33**:247.
Neivamyrmex Borgmeier, 1940, Rev. de Ent. **11**:606. Proposed for *Acamatus* Emery, which is preoccupied by *Acamatus* Schoenherr, 1833, Genera et Species Curculionidum, Tom. 1, pars prima, Parisiis, p. 20. Type of subgenus, (*Eciton (Acamatus) schmitti* Emery)=*Eciton (Neivamyrmex) nigrescens* (Cresson). (By designation of Wheeler, 1911, N. Y. Acad. Sci. **21**:157.)

The legionary ants of the United States belong to the subgenera *Labidus* and *Neivamyrmex* of the genus *Eciton*. The worker and female of *Neivamyrmex* are distinguished from those of *Labidus* by their simple, untoothed claws; the male by having three apical teeth on the seventh gastric sternum instead of two.

The worker can readily be recognized by the following characters: Frontal carinae placed close together and failing to cover insertions of the antennae; the absence of eyes or else the presence of only simple ocelluslike eyes, 12-segmented antennae, 2-segmented petiole, and absence of a constriction between the first and second gastric segments.

The extraordinary female is easily distinguished by her elongate, flattened, somewhat termitiform appearance and simple ocelluslike eyes; by having the frontal carinae placed close together and not covering the antennal insertions; by the single-segmented petiole; by the absence of ocelli, wings, and wing attachments; by the untoothed tarsal claws; by having the base of the fifth gastric sternum provided with a pair of reniform pits which are almost contiguous anteriorly and separated posteriorly by a triangular process; and by the presence of a sting.

The somewhat wasplike male has a single-segmented petiole; the apical portion of the seventh gastric sternum provided with 3 teeth; triangular, sublinear, or sickle-shaped mandibles; large eyes and ocelli; 13-segmented antennae, with the scape never longer than the combined lengths of the first 3 or 4 funicular segments; the anterior wing provided with a stigma, a radial cell, 2 cubital cells, and a discoidal cell; and toothed or simple claws.

Table Showing the Various Species of Eciton (Neivamyrmex) of the United States and the Known Castes of Each.

Species	Worker	Female	Male
arizonense Wheeler	..	..	×
californicum Mayr	×	..	..
carolinense Emery	×	×	×
commutatum Emery	×	..	..
fuscipennis Wheeler	..	..	×
harrisii (Haldeman)	..	..	×
leonardi Wheeler	×	..	..
melanocephalum Emery	×	..	..
melsheimeri (Haldeman)	..	..	×
minus (Cresson)	..	..	×
nigrescens (Cresson)	×	×	×
opacithorax Emery	×	×	×
oslari Wheeler	..	..	×
pauxillum Wheeler	×	..	..
pilosum F. Smith	×	..	×
pilosum mandibulare, new subspecies	..	..	×
wheeleri Emery	×	×	..

KEY FOR SPECIFIC IDENTIFICATION OF MAJOR WORKERS [1]

1. Head and gaster deep brownish black to black, smooth and shining 2
   Head and gaster not as described above 3
2. All of body shining except mandibles, mesopleura, metapleura, and meso-epinotal constriction; pronotum, in profile, strongly arched; ventral surface of petiolar peduncle with an acute spine directed posteroventrad (Fig. 2,2); Brazil to Louisiana, Mississippi, Oklahoma, Arkansas, and Texas ..... *pilosum* F. Smith
   Thorax strongly sculptured and opaque throughout and lighter in color than head and gaster; pronotum, in profile, weakly arched; ventral surface of petiolar peduncle with a protuberance which is smaller, less acute, and directed more ventrad; southern Arizona and Mexico ..... *melanocephalum* Emery
3. Petiole, from above, distinctly longer than broad, rather slender, not subquadrate (Fig. 2, 1) 4
   Petiole, from above, although often longer than broad, robust, subquadrate (Fig. 2, 3) 6
4. Head distinctly shining, never densely sculptured or opaque 5
   Head, thorax, petiole, and postpetiole densely punctate, opaque, with scattered foveolate impressions (Pl. 1, Fig. 4); (color varying from light reddish brown to very dark brown often approaching blackish); Florida and Virginia westward through Iowa and Nebraska, Colorado, and Arizona, into southern California ..... *nigrescens* (Cresson)
5. Thorax opaque dorsally, propleura and postpetiole shining; Florida and Virginia westward to Kansas and Missouri ..... *opacithorax* Emery
   Promesonotum distinctly shining; (hairs longer and more erect than with the preceding species); California ..... *californicum* Mayr
6. Eyes apparently absent; small species, 2-3 mm. in length or less 7
   Eyes present, although sometimes indistinct; larger species 8
7. Head strikingly elongate, approximately one and one-third times as long as broad (Pl. 1, Fig. 8); length of body 1.75-2 mm.; without a broad, distinct flange in front of antennal socket; (gaster, in profile, flattened dorsoventrally); Texas ..... *pauxillum* Wheeler[1]

1 The available workers of *pauxillum* and *leonardi* are so unusually small that they may not represent the largest workers of the two species.

Head not strikingly elongate; length of body 2-3 mm.; a distinct, broad, pellucid flange in front of antennal socket; California ..... *leonardi* Wheeler[1]

8. Frontal carina forming a broad, pellucid flange in front of antennal socket; funiculus not very strongly incrassated (Pl. 1, Fig. 5); Texas ..... *wheeleri* Emery

Frontal carina not of the conformation described above; funiculus very strongly incrassated 9

9. Dorsum of the thorax extremely smooth and shining except for the distinct suture separating the meso-epinotum; eyes very small and indistinct; (mandible with a distinct excision on superior border between basal tooth and masticatory border); antennal scape very short; funiculus remarkably incrassated (Pl. 1, Fig. 6); Texas and Arizona..... *commutatum* Emery

Sculpturing of thorax, and shape of eyes and mandibles not as described above; antenna of same general shape but not so remarkably short and strongly incrassated; Florida and North Carolina westward to Mississippi and Tennessee..... *carolinense* Emery

KEY FOR SPECIFIC IDENTIFICATION OF FEMALES

1. Head, from above, with posterior corners not, or indistinctly, produced 2

Head, from above, with posterior corners very distinctly produced, angulate or tuberculate 3

2. Thorax more heavily sculptured and opaque than head; thorax elongate, gradually and perceptibly widening anteroposteriorly; prothorax submargined laterally; posterior corners of head scarcely produced (Pl. 2, Fig. 9) ..... *opacithorax* Emery

Body smooth and shining, with scattered punctures; thorax proportionally wider, and with the posterior part of epinotum subequal in width to the metanotum; prothorax more convex, and scarcely, if at all, marginate; posterior corners of head not produced, broadly rounded (Pl. 2, Fig. 11) ..... *carolinense* Emery

3. Head with a distinct median impression near the occiput, and an impression on each lateral border, which causes the posterior corners to appear distinctly angulate or tuberculate; prothorax clearly margined; thorax elongate, gradually widening anteroposteriorly to the metanotum; head and thorax subopaque or opaque, owing to the dense and rather coarse sculpturing (Pl. 2, Fig. 10)..... *nigrescens* (Cresson)

Head with angular posterior corners but lacking the distinct lateral impressions of *nigrescens;* prothorax not margined; thorax, although elongate, of almost uniform width from posterior half of mesonotum backward; head, thorax, and remainder of body shining, even though scattered and distinct punctures on the former two (Pl. 2, Fig. 12)..... *wheeleri* Emery

KEY FOR SPECIFIC IDENTIFICATION OF MALES

1. Epinotum with a clearly defined, median, longitudinal groove where base and declivity meet; dorsum of head behind ocelli smooth, shining, concave, and with distinct, upturned occipital flange 2

Epinotum without a median longitudinal groove where base and declivity meet or else with a very weakly developed one; occipital flange either absent or vestigial 3

2. Superior border of mandible with an excision near base and apex and between these a somewhat toothlike convexity or protuberance; antennal scape approximately as long as combined length of first 4 funicular segments (Pl. 3, Fig. 13); body and wings of a general yellowish-brown color, with head, legs, and seventh gastric sternum darker..... *pilosum* F. Smith

With similar characters excepting that the mandible is more robust and the toothlike convexity of the superior border is hardly discernible (Pl. 3, Fig. 14).... *pilosum mandibulare*, new subspecies

3. Mandible sickle-shaped (Pl. 4, Fig. 15) 4

Mandible not sickle-shaped (Pl. 6, Fig. 21)..... 8

4. Head, viewed anteriorly, with strongly projecting posterior corners which are visible between the eyes and the lateral ocelli (Pl. 4, Fig. 15) 5

Head, viewed anteriorly, without posterior corners as described above; either the corners are weakly visible, or else not visible (Pl. 4, Fig. 17)..... 6

5. Wings deeply infumated; mandible extremely long, slender and curved; posterior corners of head remarkably well-developed (Pl. 4, Fig. 15); dorsal surface of gaster with short, appressed hairs .....*fuscipennis* Wheeler

Wings not infumated; mandible, though slender and curved, not extremely long; posterior corners of head less well-developed (Pl. 4, Fig. 16); dorsal surface of gaster with long, non-appressed hairs .....*melsheimeri* (Haldeman)

6. Large species, length 11-13 mm. 7

Small, slender species, length 8-9 mm. .....*minus* (Cresson)

7. Antenna with long, filiform funiculus; scape not noticeably wider than base of funiculus (Pl. 5, Fig. 18); head, from above, not remarkably broader than long; tarsal claws indistinctly toothed .....*oslari* Wheeler

Antennal funiculus not long and filiform, distinctly tapering from base to apex; scape robust, distinctly broader than base of funiculus (Pl. 5, Fig. 19); head from above remarkably broader than long; tarsal claws distinctly toothed .....*arizonense* Wheeler

8. Head with unusually large eyes and ocelli; ocelli placed on a protuberance high above general surface of head (Pl. 6, Fig. 21); body deep brown, with darker head and thorax.....*harrisii* (Haldeman)

Head with small eyes and ocelli; ocelli placed on a low protuberance, which is scarcely elevated above general surface of head (Pl. 6, Fig. 20); color variable, but never as described above 9

9. From above, dorsal surface of head rounding off anteriorly without forming a very perceptible ridge above antennal socket (Pl. 6, Fig. 20); dorsal surface of head and thorax, although sculptured, with a distinct glabrous appearance; (funiculus slender, weakly tapering from base to apex; body bicolored owing to the blackish head and thorax, and the much lighter, reddish-brown gaster) .....*opacithorax* Emery

From above, dorsal surface of head forming distinct ridges above antennal sockets; dorsal surface of thorax with a subopaque or opaque appearance.....10

10. Mandible remarkably long and slender, at least five times as long as broad; funiculus slender (Pl. 7, Fig. 22); length 9-9.5 mm. .....*carolinense* Emery

Mandible more robust, not so remarkably long and slender; funiculus robust (Pl. 7, Fig. 23); length 11-13 mm.; (dorsal surface of thorax and gaster more coarsely sculptured) .....*nigrescens* (Cresson)

ECITON (NEIVAMYRMEX) PILOSUM F. Smith

Eciton pilosa F. Smith, 1858, Cat. Hymen. Brit. Mus. **6**:151, ♀.
Labidus mexicanus F. Smith, 1859, Cat. Hymen. Brit. Mus. **7**: 7, ♂; Cresson, 1872, Trans. Amer. Ent. Soc. **4**: 194.
Eciton clavicornis Norton, 1868, Trans. Amer. Ent. Soc. **2**: 46.
Eciton (Labidus) pilosum (F. Smith), Mayr, 1886, Wien. Ent. Zeit. **5**: 120.
Eciton (Labidus) subsulcatum Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**: 440.
Labidus subsulcatum Mayr, Cresson, 1887, Trans. Amer. Ent. Soc., suppl. vol., p. 259.
Eciton mexicanum (F. Smith), Dalla Torre, 1893, Cat. Hymen. **7**: 4; Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 27.
Eciton pilosum F. Smith, Dalla Torre, 1893, Cat. Hymen. **7**: 5; Forel, 1899, Biol. Centr.-Amer. **3**: 27; Wheeler and Long, 1901, Amer. Nat. **35**: 165.
Eciton (Acamatus) pilosum (F. Smith), Emery, 1894, Bull. Soc. Ent. Ital. **26**: 183; Emery, 1900, Mem. Real Accad. Sci. Bologna **8**:524; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 412; Emery, 1910, Gen. Insect., Fasc. **102**: 25.
Eciton (Labidus) mexicanum (F. Smith), Emery, 1895, Zool. Jahrb. Syst. **8**: 260.

Eciton (Acamatus) mexicanum (F. Smith), Emery, 1900, Mem. Real. Acad. Sci. Bologna **8**: 515, fig. 19, ♂; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 414, pl. 26, fig. 11, ♂; Emery, 1910, Gen. Insect., Fasc. **102**: 26; Wheeler, 1921, Proc. Amer. Acad. Arts and Sci. **56**: 313; Smith, 1931, Jour. N. Y. Ent. Soc. **39**: 295-297.

Major worker.—Length 4-6 mm. (Pl. 1, Fig. 7).

Head approximately as broad as long; with convex sides. Posterior border visible only from above, emarginate, forming weakly produced or very feebly angulate posterior corners. Eye ocelluslike, flat, small but distinct. Mandible triangular; superior border without a basal booth; masticatory border with several small, irregular teeth on the upper half. Antennal scape extending at least its greatest width beyond posterior border of eye; funiculus not noticeably robust; segments 1 to 4 inclusive distinctly longer than broad. Frontal carina not forming a flange in front of antennal socket. Dorsal surface of promesonotum, in profile, forming a rather strong, continuous arch which occupies approximately two-thirds length of thorax; greatly elevated above epinotum and meeting epinotum in a distinct but shallow constriction. Basal and declivous surfaces of epinotum subequal in length and meeting in a bluntly rounded, obtuse angle. Pronotum without an apparent transverse carina. Thorax, from above, compressed and narrowest in region immediately posterior to front coxae. Mesothoracic spiracle appearing as a faint depression very slightly above most posterior extension of pronotum over mesonotum; metathoracic spiracle appearing as a somewhat larger depression in meso-epinotal suture and anterior to the very large, slitlike epinotal spiracle. Petiole with a very characteristic, acute, ventral spine directed posteroventrad (Fig. 2, 2). Petiolar node approximately one-eighth longer than broad, with at least one-third of the dorsal surface sloping anteriorly; posterior half slightly wider than anterior half, and with subparallel sides. Postpetiolar node distinctly broader than petiolar node, broader posteriorly than anteriorly, with rounded sides and feebly rounded anterior and posterior ends.

Mandible subopaque, with longitudinal striae and scattered piligerous punctures; pronotal collar with delicate granulate shagreening which causes this area in some lights to appear slightly subopaque; meso- and metapleura, most of sides of epinotum, and meso-epinotal constriction granulate-rugulose, and subopaque; sides of petiole and postpetiole with faint granulate shagreening, sub-

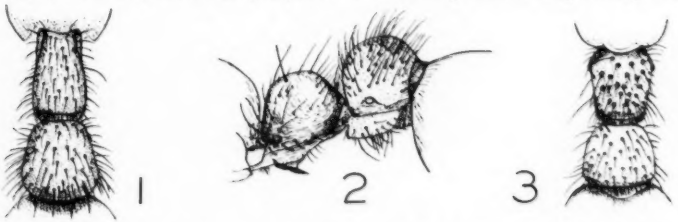


Fig. 2.—Petiole and postpetiole of major worker of (1) *Eciton (Neivamyrmex) nigrescens* (Cresson); (2) *E. (N.) pilosum* F. Smith; (3) *E. (N.) carolinense* Emery.

opaque. Remainder of body and appendages smooth and shining except funiculi and tarsi. Head with small, scattered, sparse, piligerous punctures; dorsum of thorax, petiole, and postpetiole with larger and coarser, but sparser punctures.

Hairs yellowish to grayish, fairly abundant, variable in length.

Color highly variable, ranging from almost uniform brown through brownish black to almost black, with antennal sockets, funiculi, tibiae, tarsi, and tip of gaster lighter. Often there are traces of infuscation on the head and thorax.

Male.—Length 12-13 mm. (Pl. 3, Fig. 13).

Head one and three-fourths to one and nine-tenths times as broad as long. Eye large, convex, protuberant. Ocelli large, placed on prominent protuberance above general surface of head, the summit of protuberance concave. Space between inner border of eye and lateral ocellus less than one-half diameter of lateral ocellus. Frontal carinae converging posteriorly, with sharp lateral borders and a deep median groove. Antenna of variable length; scape not remarkably stout, approximately as long as combined length of first 4 funicular segments; funicular segments 3 to 5 inclusive broader than others, thus causing the funiculus to appear tapering from base toward apex. Clypeus distinctly excised. Mandible slender, median section of inferior border straight or faintly excised; superior border with gently convex to angular protuberance, anterior and posterior to which there is a distinct excision. The large eye occupies all of side of head except a small area between it and base of mandible, and a much larger area posterodorsad of eye. Region of head posterior to ocelli, in profile, smooth, concave, with well-defined, reflexed, occipital flange. Head, from above, with well-rounded posterior corners which merge into eyes without forming perceptible angles or protuberances. Thorax strongly projecting above head. Mesonotum with well-defined anteromedian and parapsidal lines. Epinotum with a distinct, longitudinal, median groove where base and declivity meet; declivity concave. Tarsal claws not toothed or faintly so. Dorsal surface of petiole, in profile, with convexity originating very far posteriorly. Gaster elongate, moderately slender. Intermediate tooth of seventh gastric sternum short and usually blunt. Paramere, in profile, roundly pointed at apex, ventral border angulate, dorsal border with a toothlike lobe and a membranous plate extending between tooth and base of paramere.

Head, legs, and anterior border of each gastric segment smooth and shining; remainder of body somewhat less shining, especially funiculi and thorax.

Hairs yellowish, short, dense, and rather appressed on parts of the body; longer and suberect to erect on head, legs, and venter of petiole.

Head, legs, and seventh gastric sternum darker than remainder of body, which is yellowish brown to brown. Wings distinctly yellowish with light-brown or yellowish-brown veins and stigma.

The above description of the worker is based on specimens collected in a number of the Texas localities. The description of the male is drawn from specimens collected in the various localities mentioned below.

Type in British Museum of Natural History.

Type locality.—Villa Nova, Brazil.

F. Smith described the male of this species as *Labidus mexicanus* from specimens collected in Orizaba, Mexico. Wheeler (1908) synonymized *mexicanus* with *pilosum*.

Material studied.—ARKANSAS: Hot Springs, D. E. Read, ☿; Marion County, J. C. Bridwell, ♂. LOUISIANA: Baton Rouge, T. F. McGehee, ☿; Pillette, T. F. McGehee, ☿; Baton Rouge, 6-23-05, R. C. Howell, ♂; Opelousas, Pilate, ♂; Lafayette, 6-14-38, C. Landry, ♂. MISSISSIPPI: Wier, M. R. Smith, ☿; Mathiston, M. R. Smith, ☿; Kilmichael, L. C. Murphree, ☿; Sibley, Andrew Fleming, ☿; Hazelhurst, ☿; Wiggins, 6-27-30, J. P. Kislanko, ♂. OKLAHOMA: Leflore County, 8-15-31, Costner and Davis, ♂; Strang, 6-18-39, Kaiser and Nailon, ♂; Durant, 7-1-10, in W. D. Hunter collection, ♂; Ardmore, 6-26-05, C. R. Jones, ♂. TEXAS: Austin, W. M. Wheeler, ☿; New Braunfels, W. M. Wheeler, ☿; Ranger, D. E. Read, ☿; Lockhart, D. E. Read, ☿; Cameron, D. E. Read, ☿; Victoria, J. D. Mitchell, ☿; Victoria, 7-6-?, A. McLaughlin, ♂; Pecos, 6-26-?, ♂; Big Bend, Brewster County, R. H. Baker, ♂; Bastrop County, 7-12-37, ♂; Daingerfield, 7-9-37, ♂; Brownsville, 6-?-?, in Cornell University collection, ♂; Wharton, 6-24-17, in Cornell University collection, ♂; Colorado County, 6-24-22, G. O. Wiley, ♂; Llana, 6-10-06, F. C. Pratt, ♂; Columbus, ♂; Comanche, 7-23-04, C. R. Jones, ♂; Cypress Mills, in W. H. Ashmead collection, ♂; Dayton, 7-3-18, E. L. Diven, ♂; Travis County, 7-4-02, M. Holliday, ♂; Sweetwater, 7-10-37, ♂.

MEXICO: Tanque de Malone, La Babia, Coahuila, 6-20-38, ♂; Buena Vista, Sierra del Carmen, Coahuila, 7,000 feet, 7-7-38, ♂; Las Ruscias, Musquiz, Coahuila, 7-3-38, ♂; Rancho Harmova, Vera Cruz, H. Schwartz, ♂; Cordoba, 5-16-08, F. Knab, ♂.

Wheeler (1908) records *mexicanum* from Brownsville and Austin, Tex.; Las Cruces, N. Mex.; and Nogales, Ariz. I have not seen the Las Cruces specimens, but the ones he records from Nogales are what I propose to call a new subspecies of *pilosum*, that is, *mandibulare*. It is also likely that the New Mexican individuals are this new subspecies.

The major worker is characterized by its color and sculpture; feebly produced, almost rounded posterior corners of the head; long, slender scape; strongly convex promesonotum; and the very distinctive ventral spine of the petiole. The male can easily be recognized by the shape of the mandibles and frontal carinae; large eyes and ocelli, the latter placed on a protuberance above the general surface of the head; length and form of the scape; smooth, concave area back of ocelli; pronounced occipital flange; the distinct longitudinal median groove where base and declivity of epinotum meet; the yellowish-brown body with yellowish wings and darker head, legs, and seventh gastric sternum.

Although all the specimens have most of the characters mentioned in the description, a number of the characters are very variable, these being the general robustness and shape of mandibles; length and shape of antennae; size and convexity of eye; width of space between frontal carinae; distance between inner border of eye and lateral ocellus; depth of body color; length of pilosity. The tooth on the superior border of the mandible may vary considerably in size and shape but is always prominent enough to attract immediate attention.

The species ranges from Oklahoma, Texas, Mississippi, and Arkansas southward into Brazil.

In the United States males have been collected from June into August but most commonly during June and July. Although *pilosum* is one of the most common forms of *Eciton*, the female has not yet been recognized and described.

Eciton (Neivamyrmex) pilosum mandibulare, new subspecies

Male.—Length 13 mm. (Pl. 3, Fig. 14).

Head one and eight-tenths to one and nine-tenths times as broad as long. Ocelli large, placed on protuberance above general surface of head, summit of protuberance concave; space between inner border of eye and lateral ocellus less than half diameter of ocellus. Antenna short; scape robust, slightly shorter than combined length of first 4 funicular segments; funiculus very distinctly tapering from base toward apex, clearly wider through segments 2 to 5 inclusive than elsewhere. Toothlike convexity on superior border of mandible very faint, hardly discernible. Frontal carinae sharply margined but farther apart and more nearly parallel than with *pilosum*, and apparently also more deeply grooved. Clypeus excised. Eye large, convex, strongly protuberant. The large eye, in profile, occupies all of the side of the head except a narrow area above the base of the mandible, and a much larger area posterodorsad of the eye. Region of head posterior to ocelli smooth, concave, with well-defined occipital flange. Head, from above, with well-rounded posterior corners which merge into eyes without forming perceptible angles. Thorax strongly projecting anteriorly over head. Prothorax, from above, more truncate anteriorly, narrower, and with better defined humeri than in *pilosum*. Mesonotum with anteromedian and parapsidal lines. Epinotum with distinct longitudinal median groove where base and declivity meet, declivity concave. Tarsal claws faintly toothed. Dorsal surface of petiole in profile, most convex very far posteriorly; ventral surface with protuberance. Gaster elongate, moderately slender. Intermediate tooth of seventh gastric sternum short but somewhat more acute than that of *pilosum*. Paramere differing from that of *pilosum* in having a more truncate apex, and a more feebly developed tooth on the dorsal border.

Most of the head, the legs, and anterior portion of each gastric segment shining; remainder of body including appendages less shining, especially funiculi. Entire body with coarser punctate-shagreening than in *pilosum*.

Hairs yellowish, dense, and rather appressed on body; longer and more suberect to erect on head, legs, and venter of petiole. Hairs apparently longer and less appressed than those of *pilosum*.

Head, legs, and seventh gastric sternum darker than remainder of body and appendages, which are yellowish brown. Color deeper than that of *pilosum*. Wings distinctly yellowish, with brownish veins and stigma.

A holotype and one paratype in the United States National Museum bear U. S. N. M. No. 55464. The other paratype is in the collection of Cornell University.

Type locality.—Thirty miles east of Quijotoa, Pima County, Ariz.

A specimen labeled Nogales, Ariz., Oslar, Cornell University Lot 292, sub. 21, I also consider to be this new subspecies although it bears a hand-written label, apparently W. M. Wheeler, *Eciton mexicanum*. This individual agrees with the cotype of *mandibulare* except that the prothorax does not appear quite so narrow anteriorly, the color is not so deep, and the hairs not so long. Another specimen from the San Rita Mountains, Ariz., 4,000-5,000 feet, August 29, 1924, A. A. Nichol, agrees with the cotypes except for its lighter color, shining body, finer pilosity, and paler wings. Wheeler (1908) mentions having examined specimens of *mexicanum* collected July 18 by Oslar at Nogales, Ariz. I have not seen the specimens, but they may belong to this subspecies.

The difference between *mandibulare* and the typical *pilosum* are clearly stated above. As the shape of the mandible of this new subspecies is one of the easiest and best characters for distinguishing it, I have emphasized this fact by calling the new form *mandibulare*.

Males have been collected from early July to late August.

ECITON (NEIVAMYRMEX) MELANOCEPHALUM Emery

Eciton (Acamatus) melanocephalum Emery, 1895, Zool. Jahrb. Syst. 8:260, ☿.
Eciton (Acamatus) melanocephalum subsp. *xipe* Wheeler, 1914, Jour. N. Y. Ent. Soc. **22**: 41, ☿. New synonymy.

Major worker.—Length 4.5-5.5 mm.

Head approximately as broad as long; broadest anteriorly; with convex sides and very weakly emarginate posterior border. Eye ocelluslike, very distinct against black background of head. Mandible rather large, subtriangular, with well-defined superior, inferior, and masticatory borders; superior border without any distinct excision or protuberance. Antennal scape large, curved; exceeding posterior border of eye by at least its greatest width; all segments of funiculus distinctly longer than broad. Promesonotum, in profile, very feebly arched; meso-espinotal constriction weakly developed. Thorax without dorsal sutures. Pronotum with very small but distinct transverse carina. Petiole longer than broad, with somewhat abrupt posterior surface and a more gently sloping anterior surface; anterior surface constricted before its termination at the thorax. Legs rather long. Petiolar peduncle with very small anteroventral tooth, which is directed more ventrad than posteriorly. Postpetiole broader than petiole, subtrapezoidal, broader posteriorly than anteriorly, with convex sides and straight anterior end.

Head, dorsal surface of petiole and postpetiole, and gaster smooth and shining; mandibles, funiculi, thorax, and tarsi subopaque or opaque. Mandibles longitudinally striated, with scattered piligerous punctures. Head highly polished, bearing very small, scattered, piligerous punctures. Thorax covered with dense, granular punctures, which are interspersed with foveolae; meso- and metapleura more coarsely sculptured, the sculpturing of a rugose-reticulate nature; pronotum longitudinally rugulose.

Body with numerous suberect to erect, yellowish hairs of unequal length, some of which are unusually long.

Head and gaster almost black. Mandibles, anterior border of head, thorax, legs, petiole, and postpetiole of a much lighter reddish brown.

Among the specimens studied were cotypes of *melanocephalum* from the collections of the United States National Museum and also cotypes of the subspecies *xipe* from the collection of W. M. Mann. The description has been drawn largely from specimens of *xipe*.

Cotypes in the United States National Museum.

Type locality.—Tepic, Mexico.

Material studied.—ARIZONA: Atascosa Mountain, southern Arizona, 10-2-38, 4,000 feet, under stone in shade near stream, rolling terrain, Robert G. Wesson.

MEXICO: San Miguel, Hidalgo, W. M. Mann.

MEXICO: San Miguel, Hidalgo, W. M. Mann.

The major worker of *melanocephalum* can be readily distinguished by the form of the mandibles; size and shape of the scape; conspicuous eyes; rounded posterior corners of the head; the contrast in color and sculpture of head and gaster as compared with thorax; sculpture of pronotum; and the form of the petiole and postpetiole.

The color of the thorax varies considerably, ranging from light yellowish brown through deeper reddish brown to almost blackish; the color seems more variable in smaller workers than in the larger workers. The sculpture of the thorax also varies greatly, being much more rough in some individuals than in others. The head of the smaller worker is uniformly longer and narrower than the head of the major worker.

The major worker is most likely to be confused with that of *pilosum*. It may be distinguished, however, by the different color and sculpture of the thorax; the more weakly arched pronotum; and the weakly developed tooth on the petiolar peduncle; which is never so large or acute, or directed so far posteriorly, as that of *pilosum*.

Wheeler based the subspecies *xipe* mainly on two characters, color of the body and width of petiole with relation to its length. As stated, the color of *melanocephalum* is highly variable. A study of the petiole of all the specimens before me shows no characters that are of any signficance.

Apparently *melanocephalum* is a Mexican form which probably reaches its most northern limit in southern Arizona.

ECITON (NEIVAMYRMEX) NIGRESCENS (Cresson)

Labidus nigrescens Cresson, 1872, Trans. Amer. Ent. Soc. **4**: 194, ♂; Cresson, 1887, Trans. Amer. Ent. Soc., suppl. vol., p. 259.

Eciton sumichrasti authors (not Norton), Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**: 440 (part); Mayr, 1886, Wien. Ent. Zeit. **5**: 120; Forel, 1899, Biol. Centr.-Amer. **3**: 27 (part); Wheeler, 1900, Amer. Nat. **34**: 563, figs. 1, 2, 3, ☿, ♀. Descriptions and figures of 2 females from different nests (part).

Eciton nigrescens (Cresson), Dalla Torre, 1893, Cat. Hymen. **7**: 5.

Eciton (Acamatus) schmitti Emery, 1894, Bull. Soc. Ent. Ital. **26**: 183, ♀; Emery, 1895, Zool. Jahrb. Syst. **8**: 258; Wheeler and Long, 1901, Amer. Nat. **35**: 161, figs. 1, 2b, ♂; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 410, pl. 26, fig. 13, ♂; Emery, 1910, Gen. Insect., Fasc. **102**: 25; Smith, 1927, Ann. Ent. Soc. Amer. **20**: 401.

Eciton (Labidus) nigrescens (Cresson), Emery, 1895, Zool. Jahrb. Syst. **8**: 261.

Eciton schmitti Emery, Forel, 1899, Biol. Centr.-Amer. **3**: 28.

Eciton (Acamatus) nigrescens (Cresson), Wheeler, 1908, Bull. Amer. Must. Nat. Hist. **24**: 417, pl. 26, figs. 7, 9; Emery, 1910, Gen. Insect., Fasc. **102**: 27; Smith, 1938, Proc. Ent. Soc. Wash. **40**:157.

Major worker.—Length 4-5 mm. (Pl. 1, Fig. 4).

Head scarcely longer than broad, narrowed posteriorly; posterior border emarginate, forming very distinctly produced, sharp, angular corners which are often somewhat outwardly curved but not so pronouncedly as with *wheeleri*. Eye ocelluslike, convex, usually very distinct because of the opaque appearance given head by sculpturing. Mandible with basal tooth on superior border lacking or very faintly indicated; margin between where his tooth should be and masticatory border convex, instead of straight or excised as in some of the other species; discal area of exterior surface flattened. Scape approximately three and one-half times as long as wide, extending beyond posterior border of eye a distance almost equivalent to greatest width of scape; funiculus with segments 2 to 4 inclusive at most scarcely broader than long. Frontal carina not forming a broad, distinct flange in front of antennal socket as in *wheeleri*. Dorsum of thorax, from above, less convex laterally than in *wheeleri*, thus giving thorax a more compressed appearance. Side of prothorax extending above fore coxae as a prominent, somewhat reflexed lobe. Promesonotum, in profile, appearing as an arch which merges into basal surface of epinotum without forming as abrupt an angular termination as in some species. Basal surface of epinotum meeting declivity in a rather rounded, obtuse angle. Petiole, from above, approximately two-thirds as broad as long; anteroventral surface of peduncle with bluntly rounded tooth. Postpetiole, from above, subtrapezoidal, slightly shorter than petiole, approximately as long as broad; almost anterior half somewhat laterally margined on each side.

Head, thorax, petiole, and postpetiole opaque, covered with dense granulate punctures, interspersed with coarse foveolate impressions; head and thorax most heavily sculptured, petiole and postpetiole least of all; legs subopaque or faintly shining, gaster smooth and shining. Discal surface of mandible bearing fine rugulae and coarse, scattered punctures which give an opaque appearance; borders of mandible more shining.

Hairs yellowish, rather abundant, of various lengths, suberect to erect, many unusually long.

Head, thorax, petiole, and postpetiole usually deep reddish brown, sometimes almost blackish; gaster and legs slightly lighter. Eye yellow or amber.

Female.—Length 10-14 mm. (Pl. 2, Fig. 10).

Head approximately as long as broad, broadest anteriorly; posterior border

emarginate. Eye ocelluslike, rather large, much larger and more distinct than that of *opacithorax*. Mandible of somewhat similar shape to that of *opacithorax* but usually more robust. Scape curved, rather robust, approximately one half length of head. Region adjacent to and also somewhat posterior to frontal area rather angularly produced anteriorly. A conspicuous median groove extending posteriorly from clypeus toward vertex, becoming feebler posteriorly. Dorsal surface of clypeus concave, middle of anterior border broadly but shallowly excised. Dorsal surface of head with deep median impression near occipital border and a groove leading from this toward front of head, also with a distinct impression on each side of head in front of posterior corners; these impressions giving back of head an extended effect and causing posterior corners to have an unusually angulate or tuberculate appearance. Thorax, from above, more than twice as long as wide, gradually increasing in width posteriorly to metanotum; epinotum not so wide as head. Dorsal thoracic sutures distinct. Pronotum approximately as broad as long, marginate anteriorly and laterally. Mesonotum with a somewhat angular anterior border, and a more broadly angular posterior border. Epinotum broader than long, with bluntly angular posterior corners. Mesonotum and epinotum with conspicuous longitudinal, median impression. Petiole, in profile, of approximately same height as epinotum but not so long; peduncle with large, convex protuberance beneath; from above, not one and a half times as broad as long, scarcely broader in front than behind, and with somewhat subparallel sides, and a deep median, longitudinal impression which widens posteriorly.

Head and thorax opaque, owing to the dense granulate shagreening and the scattered, deep punctures. Petiole more finely sculptured than head or thorax.

Hairs fairly abundant on head, thorax, petiole, and appendages; clypeus, gula, mandibles, and scapes with longer hairs of variable length.

Light or deep ferruginous brown.

Male.—Length 11.25-13 mm. (Pl. 7, Fig. 23).

Head approximately one and eight-tenths times as broad as long; posterior border rounded. Eye rather small, moderately convex, and protuberant. Ocelli very small, placed on low protuberance which is only slightly elevated above general surface of head; summit of protuberance concave; lateral ocellus far removed from eye, this space often greater than the space between the two lateral ocelli. Frontal carinae converging behind, with distinct but somewhat feeble groove between them leading to anterior ocellus. Ridge over antennal socket remarkably well developed, forming a large, thick welt which tends partly to obscure the posterior border of the head, when the head is viewed anteriorly. Antenna distinctly more robust than that of *opacithorax;* scape slightly shorter than combined length of first 3 funicular segments; segments 2 to 6 inclusive much more broadened than those of *opacithorax*, all segments except first clearly longer than broad. Mandible moderately elongate to rather elongate, with subparallel superior and inferior borders basally, superior border converging with inferior border somewhere between apical half to third of

mandible and forming a rather blunt point. Head, from above, with very prominent frontal carinae and a very strong, protuberant ridge above each antennal socket; a transverse groove behind each ridge. Head not noticeably extended behind eyes, posterior corners well rounded, the curvature blending into that of eyes. Eye, in profile, narrowed above, not occupying all of side of head, there being an area mesad and ventrad of it larger than similar areas of *opacithorax*, and a much larger area posterodorsad than the two areas mentioned; head behind ocelli convex, without occipital flange. Thorax, in profile, approximately one and one-half times as long as high, not extended anteriorly above head. Prothorax anteriorly with a distinct, transverse impression. Epinotum truncate in appearance but really weakly concave. Mesonotum with distinct anteromedian and parapsidal lines. Tarsal claws feebly toothed. Gaster rather robust, more noticeably so than in *opacithorax;* with pronounced constrictions between segments, and a transverse impression near base of sixth gastric tergum. Intermediate tooth of seventh gastric sternum small, often not clearly seen.

Body more opaque than that of *opacithorax*, especially on dorsum of head and thorax, where the coarse punctation and general ground surface of these regions obscure the shining effect. Gaster also more coarsely sculptured than that of *opacithorax*.

Hairs light yellowish or grayish to deeper yellow, sometimes almost golden; rather closely appressed on all parts of body except antennal scapes, head, and ventral surfaces of thorax and petiole, where they are longer and more nearly erect.

Head and thorax almost black; gaster lighter brown; funiculi and tarsi usually lighter. Wings ranging from subhyaline through slightly infuscated to deeply infuscated; veins and stigma brownish to blackish.

The worker has been described from cotype specimens and also from specimens collected in the various localities cited below. The female has been described from the specimens mentioned in the locality list and the male from the holotype and from specimens cited in the same list.

Holotype in Academy of Natural Sciences of Philadelphia.

Type locality.—Texas, G. W. Belfrage.

Material studied.—ALABAMA: Kushla, A. H. Sturtevant, ☿; Pritchard, L. C. Murphree, ☿; Linville, L. C. Murphree, ☿; Decatur, L. C. Murphree, ☿; Florence, Mrs. F. F. Moore, ♂; Birmingham, 10-21-40, J. M. Robinson, ♂. ARIZONA: Oracle, W. M. Wheeler, ☿; Ramsey Canyon, Huachucha Mountains, W. M. Mann, ☿; Texas Pass, in Cornell University collection, ☿; Pinal Mountains, 8,000 feet, 8-16-32, R. A. Flock, ♂. CALIFORNIA: Riverside, C. M. Zcholske, ☿. COLORADO: Colorado Springs, W. M. Wheeler, ☿; Salida, W. M. Wheeler, ♀ associated with ☿. FLORIDA: Sanford, D. E. Read, ☿; Green Cove Springs, D. E. Read, ☿; Woodville, D. E. Read, ☿; Lessburg, C. C. Goff, ☿. GEORGIA: Mount Vernon, H. T. Vanderford, ☿; Commerce, H. T. Vanderford, ☿. ILLINOIS: Anna, L. C. Murphree, ☿; Quincy, ?-?-37, T. E. Musselman, ♂ associated with ☿. IOWA: Sioux City, C. N. Ainslie, ☿. KANSAS: Manhattan, R. C. Smith, ☿; McPherson, W. Knaus, ☿; Riley County, 9-27-?, J. B. Norton, ☿ associated with ♂; Riley County, 9-?-?, F. Marlatt, ♂. LOUISIANA: Tallulah, T. F. McGehee, ☿; New Roads, T. F. McGehee, ☿; Tangi-

pahoa, T. F. McGehee, ☿; Carencro, T. F. McGehee, ☿; Thibodeaux, E. K. Bynum, ☿; Franklin, E. K. Bynum, ☿; Houma, J. W. Ingram, ☿; New Orleans, 10-15-30, A. K. Pellitt, ♂. MISSISSIPPI: West Point, M. R. Smith, ☿; Starkville, M. R. Smith, ♀ associated with ☿; Starkville, W. W. Love, ♀ associated with ☿; Laurel, M. R. Smith, ☿; Aberdeen, M. R. Smith, ☿; Maben, M. R. Smith, ☿; Columbus, M. R. Smith, ☿; Wiggins, L. C. Murphree, ☿; Bond, L. C. Murphree, ☿; Quitman, L. C. Murphree, ☿; Quitman, L. C. Murphree, ☿; Shaw, L. C. Murphree, ☿; Centreville, W. L. Gray, ☿; Sibley, Andrew Fleming, ☿. MISSOURI: Saint Louis County, Phil Rau, ☿; Cedar City, Donaldson, ☿; Cape Girardeau. D. E. Read, ☿; Poplar Bluff, D. E. Read, ☿; Columbia, Mary Talbot, ☿; Saint Charles, Mary Talbot, ☿; Jefferson City, A. C. Burrill, ☿. NEBRASKA: Lincoln Orlando Bare, ☿; Roac, Orlando Bare, ☿; Clearwater, Orlando Bare, ☿. NORTH CAROLINA: Bat Cave, Henderson County, W. M. Wheeler, ☿; Wilmington, H. T. Vanderford, ☿. NEW MEXICO: Clayton, W. M. Wheeler, ☿; Los Vegas, W. M. Wheeler, ☿. OKLAHOMA: Wichita National Forest, W. Fisher, ☿; Oklahoma City, Bob Siegel, ☿. SOUTH CAROLINA: Clemson College, M. R. Smith, ☿. TENNESSEE: Athens, L. C. Murphree, ☿; Clifton, L. C. Murphree, ☿; Henderson, L. C. Murphree, ☿; Cades Cove, Great Smoky Mountain National Park, A. C. Cole, Jr., ☿; Montvale Springs, C. H. Kennedy, ☿; Nashville, 11-14-39, Mrs. A. R. Laskey, ♂; near Nashville, 11-?-39, L. G. Wesson, Jr., ♂ associated with ☿. TEXAS: Del Rio, W. M. Wheeler, ☿; Dallas, H. T. Vanderford, ☿; Wharton, L. C. Murphree, ☿; Carthage, D. E. Read, ☿; Commerce, D. E. Read, ☿; West Columbia, D. E. Read, ☿; Cleburne, T. F. McGehee, ☿; Palacios, T. F. McGehee, ☿; Juno, in Cornell University collection, ☿; Hightower, E. R. Kalmbach, ☿; Willis, J. C. Bridwell, ☿; Austin, 10-13-89, W. M. Wheeler, ♂ associated with ☿; Sarita, 11-30-11, ♂; Edinburg, S. Mulaik, ♂. VIRGINIA: Norfolk, H. T. Vanderford, ☿.

The shape of the mandibles and petiole of the major worker are highly characteristic, as are also the nature of the body sculpturing and color. Also noteworthy are the long scape, the prominent pronotal carina, and the absence of a broad flange in front of the antennal socket. The major worker varies considerably in sculpture and color. The pilosity may also vary in length, but this is often due to wear. The general color ranges from light reddish brown through dark reddish brown into a deep infuscation that approaches black. The sculpturing on the postpetiole is sometimes so delicate as to give this region a slightly shining appearance. The foveolate impressions may vary from a few scattered ones on some specimens to numerous ones on others. Individuals with only a few shallow impressions resemble *opacithorax;* those those with coarser and more numerous impressions approach *sumichrasti* in appearance. There are intergradations in sculpturing between these extremes. The worker is most likely to be confused with that of *opacithorax*, which it closely resembles in structure and pilosity but from which it differs noticeably in shape of mandibles and nature of sculpturing. The head and usually the postpetiole of *nigrescens* are heavily sculptured and opaque. The same regions in *opacithorax* are shining and almost free of conspicuous sculpturing.

The salient characters of the female, and also the means by which this caste can be distinguished from the female of *opacithorax*, are given in the discussion of the latter species and need not be repeated here. There is variation in size of body, shape of mandibles, depth and shape of petiolar impressions, length and abundance of hair, color, and amount of sculpture. The mandibles of some specimens are shaped much like those of *opacithorax* but are broader in porportion to their length. In general, the superior border of

the mandible approaches the inferior border toward the apex, making a longer and somewhat more pronounced curve before forming the apical point. The median longitudinal impression on the petiole of most specimens is rather deep, extending the length of the petiole and somewhat widening posteriorly; the Colorado specimen, though, has a very shallow impression. The hair on the body is generally longer and more abundant than that of *opacithorax,* but this is not always true. The color may range from light ferruginous brown to dark ferruginous brown. The sculpture, though generally similar to that of *opacithorax,* is usually much coarser, the sculpture on the head being especially rougher.

The best characters for distinguishing the male are given in the key. Typical specimens agree very closely with the above description, especially in possessing strongly developed frontal carinae; ridges over antennal sockets; rather robust antennae; heavily sculptured body of which the dorsum of the head and thorax is noticeably subopaque owing to the coarser punctation and general nature of the ground surface; blackish head and thorax with slightly lighter gaster; and light-yellowish or grayish pile covering the body. The males are highly variable, different individuals varying with regard to length and robustness of mandibles; depth of groove between frontal carinae, as well as shape of carinae; amount of development of the longitudinal ridge mesad of each eye, and of the ridge above antennal socket; and length of space between lateral ocellus and eye. The thorax may be higher in proportion to its length and possess a weaker transverse prothoracic impression. The sculpturing may be feebler so that parts of the body are less dull, this being especially true of the sides of the thorax. The color of the pilosity may range from light yellowish or grayish to an almost golden yellow; and that of the wings from subhyaline through slightly infuscated to almost blackish.

Eciton nigrescens is apparently the most widely distributed and most common species in the United States. From Texas and Kansas eastward males have been collected from September into November.

ECITON (NEIVAMYRMEX) OPACITHORAX

Eciton (Acamatus) californicum subsp. *opacithorax* Emery, 1894, Bull. Soc. Ent. Ital. **26**: 184, ♀; Emery, 1895, Zool. Jahrb. Syst. **8**: 259, ♀; Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 28.

Eciton (Acamatus) opacithorax Emery, 1900, Mem. Real. Accad. Sci. Bologna **8**: 524. Wheeler and Long, 1901, Amer. Nat. **35**: 163, 173, fig. 2e ♂, fig. 3, ♀; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 411, pl. 26, fig. **4**, ♂; Emery, 1910, Gen. Insect., Fasc. **102**: 25.

Eciton (Acamatus) carolinense Wheeler (not Emery), 1921, Proc. Amer. Acad. Arts and Sci. **56**:314-316, figs. 8a, 8b, ♀.

Major worker.—Length 4-5 mm.

Head approximately as broad as long, narrowed posteriorly; posterior border emarginate, forming produced, angular corners which are not clearly curved outwardly as in *wheeleri.* Eye ocelluslike, distinct, though usually less perceptible than that of *nigrescens* because of the less opaque background.

Margin on superior border of mandible between basal tooth and masticatory border straight (excised in *commutatum*, convex in *nigrescens*). Antennal scape robust, long, three and three-fourths to four and one-third times as long as broad; when extended backward, noticeably surpassing posterior border of eye; funiculus not noticeably robust, segments 2 to 4 inclusive, approximately as broad as long. Frontal carina not forming a broad, pellucid flange in front of antennal socket as is *wheeleri*. Thorax, from above, with convex dorsum and usually a very distinct transverse pronotal carina; side of prothorax extending above fore coxa as a somewhat reflexed lobe. Promesonotum, in profile, forming a rather long, even, gentle arch, which is slightly elevated above epinotum. Meso-epinotal constriction weakly indicated in some specimens, well defined in others. Base and declivity of epinotum subequal, the two surfaces meeting to form a distinct, obtuse angle. Petiole somewhat slender, clearly longer than broad (approximately five-eighths as broad as long), of same general shape as that of *nigrescens;* with anteroventral tooth. Postpetiole, from above, very slightly shorter but distinctly broader than petiole, subtrapezoidal, almost as long as broad.

Mandible opaque in some lights; bearing longitudinal striae and scattered piligerous punctures. Head smooth and shining or very delicately shagreened, with distinct but scattered punctures; posterior corners often with a few foveolate impressions. Thorax opaque, bearing dense, granulate punctures which are dorsally interspersed with scattered foveolate impressions (foveolate impressions similar to those of *nigrescens* but never so coarse or abundant); propleura, and sometimes the meso- and metapleura, slightly shining. Petiole with sculpturing similar to that of thorax but never so coarse, thus subopaque rather than opaque. Postpetiole usually, and gaster always, smooth and shining.

Hairs grayish or yellowish, rather abundant, suberect to erect, of various lengths, some strikingly long; some of the hair on gaster shorter and more appressed than elsewhere.

Light to dark reddish brown; thorax usually darkest; gaster and legs lighter than head and petiole.

Female.—Length 15 mm. (Pl. 2, Fig. 9).

Head approximately as long as broad; broadest anteriorly; with rounded posterior corners and weakly emarginated posterior border. Eye ocelluslike, small and indistinct, slightly closer to posterior border than to anterior border. Mandible elongate, narrow, with somewhat subparallel superior and inferior borders, superior border obliquely descending near apex to form a distinct, sharp-pointed tooth. Scape curved, robust, approximately one-half length of head. Region adjacent to and also somewhat posterior to frontal area with a strong, transverse, angular anterior protuberance. A deep median groove extending from clypeus toward vertex, becoming weaker posteriorly. Dorsal surface of clypeus concave, middle of anterior border broadly, but not deeply excised. Dorsal surface of head with a distinct median impression near occipital border, and a faint groove extending anteriorly. Posterior corners feebly produced, not tuberculate and not sharply angulate. Thorax, from

above, approximately twice as long as wide, gradually increasing in width posteriorly; epinotum not so wide as head. Promesonotal, mesometanotal, and meta-epinotal sutures distinct. Pronotum about as long as broad, marginate anteriorly and submarginate laterally. Mesonotum with somewhat angular anterior border and a more broadly angular posterior border. Epinotum broader than long, with bluntly angular posterior corners. Mesonotum with very feeble, scarcely discernible, longitudinal median impression; epinotum with a much broader and deeper impression. Thorax, in profile, approximately 3 times as long as high. Petiole about as high as epinotum but not so long; with a large, convex protuberance or tooth beneath; from above, one and one-third to one and one-half times as broad as long, with convex sides and a longitudinal median impression, which noticeably widens posteriorly. Gaster elongate.

Thorax opaque owing to the dense granulate shagreening and the numerous coarse, scattered punctures. Head rather shining because of the finer sculpturing. Petiole more feebly sculptured than thorax but scarcely as shining as dorsal surface of head.

Hairs yellowish, short; rather abundant on head, thorax, petiole, and appendages; mandibles, clypeus, gula, and scapes with longer hairs of various lengths.

Ferruginous brown with legs and antennal scapes lighter; frontal groove, borders of mandible, and clypeus darker.

Male.—Length 10-11 mm. (Pl. 6, Fig. 20).

Head approximately one and seven-tenths times as broad as long; posterior border well rounded. Eye rather small, moderately convex, protuberant. Ocelli very small, placed on low protuberance, which is scarcely raised above general surface of head; summit of protuberance concave. Frontal carinae converging behind, with distinct median groove between them leading to anterior ocellus. Ridge above antennal socket scarcely perceptible. Middle of anterior border of clypeus straight or feebly excised. Antenna rather slender; scape approximately as long as combined length of first 3 funicular segments; funiculus subfiliform, very slightly broadened through segments 2 to 6 inclusive, all segments except first distinctly longer than wide. Mandible moderately elongate to noticeably elongate, with somewhat subparallel superior and inferior borders basally; superior border sloping obliquely toward inferior border at approximately apical third of mandible to form a rather blunt tip. Head, from above, not noticeably extended behind eyes, with well-rounded corners which blend evenly into eyes; dorsum rather convex, rounding off anteriorly in such a manner that the ridge above the antennal socket is either absent or feebly developed. Lateral ocellus far removed from eye, space between the two almost equivalent to space between the two lateral ocelli. Eye, in profile, narrowed above, not occupying all of side of head, there being a small area ventrad and mesad of it, and a very much larger area posterodorsad. Region of head posterior to ocelli convex, without occipital flange. Thorax not projecting prominently above head. Prothorax with distinct transverse impression anteriorly.

Mesonotum with rather distinct anteromedian and parapsidal lines. Epinotal declivity appearing subtruncate but really concave. Gaster slender to moderately robust; sixth gastric tergum with a transverse impression near base. Seventh gastric sternum with 2 acute lateral teeth and a somewhat blunter intermediate tooth. Paramere, in profile, with a distinct median excision on the ventral border and a prominent basal, ventral angle.

All parts of body and appendages more or less shining in certain lights except the funiculi, and sometimes the dorsal surface of petiole. Head especially shining regardless of the punctures scattered over it. Sides and dorsum of thorax wtih numerous, distinct punctures; punctures, however, not obscuring the rather shining surface.

Hairs light yellowish to deep yellowish; suberect to erect on scape, head, legs, and venter of thorax and petiole; more appressed on dorsum of thorax and especially on the gaster.

Head, thorax, petiole, legs, and sometimes base of first gastric segment blackish; mandibles, funiculi, tarsi, and gaster light brown or reddish brown. Wings ranging from very feebly infuscated to blackish, the veins and stigma brownish black or black.

Description of worker based on cotypes, and also on specimens from a number of the localities mentioned below. Female described from the Clayton, Ga., specimen. This is the same female which was erroneously described and figured by Wheeler as *carolinense* (Wheeler, 1921). On the pin with it is a worker of *opacithorax*. The male has been described from the specimens listed below.

Cotypes in the United States National Museum.

Material studied.—ARKANSAS: W. J. Baerg, ☿. FLORIDA: Leesburg, C. C. Goff, ☿; Saint Augustine, C. T. Brues, ☿; Daytona, 11-10-11, G. W. Englehardt, ♂; Lutz, W. R. Vosburgh, ♂. GEORGIA: Clayton, W. T. Davis, ♀ associated with ☿; Lawrenceville, H. T. Vanderford, ☿; Atlanta, 11-4-34, P. W. Fattig, ♂. KANSAS: Manhattan, W. P. Hayes, ☿; Lawrence, 9-?-96, H. W. Menke, ♂. MISSISSIPPI: Sibley, Andrew Fleming, ☿; Vicksburg, W. J. Wallace, ☿; Quitman, L. C. Murphree, ☿; Summit, L. J. Goodgame, ☿; Louisville, M. R. Smith, ☿. MISSOURI: Willard, 10-5-20, ♂. NEW MEXICO: Jemez Springs, 6,400 feet, 9-30-16, John Woodgate, ♂. NORTH CAROLINA: Charlotte, H. T. Vanderford, ☿; Belmont, P. J. Schmitt, ♀ associated with ☿. OKLAHOMA: Payne County, 10-7-36, A. E. Hixson, ♂. SOUTH CAROLINA: Clemson College, M. R. Smith, ☿; Pendleton, M. R. Smith, ☿. TENNESSEE: Greenville, C. A. Dennis, ☿; Graystone Mountain, C. A. Dennis, ☿; Cold Spring Mountain, C. A. Dennis, ☿; Walkerton, C. A. Dennis, ☿; Townsend, C. A. Dennis, ☿; Gatlinburg, Mary Talbot, ☿. TEXAS: Austin, W. M. Wheeler, ☿; Jacksboro, T. F. McGehee, ☿; Eastland, T. F. McGehee, ☿; Austin, 10-27-99, W. H. Long, ♂.

The major worker is most likely to be confused with that of *nigrescens*, which it resembles in structure, especially in the shape of the petiole and postpetiole. From *nigrescens* it can be distinguished, however, by the nature of the sculpturing and the color of body. The head, thorax, petiole, and postpetiole of *nigrescens* are opaque, whereas in *opacithorax* this is true only of the thorax and petiole. The worker of *opacithorax* is generally of a lighter color;

has the eye less distinct; a feebler pronotal carina; a straight instead of a convex margin on the superior border of the mandible between the basal tooth and the masticatory border; and the posterior corners of the head not so noticeably curved outward. There is considerable variation among different individuals in sculpture, pilosity, color, and amount of development of the pronotal carina. Some specimens have such feeble sculpturing that the head and postpetiole are strikingly smooth and shining, whereas other specimens have these regions more heavily sculptured, tending to be subopaque. Although the meso- and metapleura are usually opaque in most individuals, they are somewhat smooth and shining in others. The variation in length of pilosity is often due to wear, as is evidenced by the truncate tips of the hairs. The color may range from a light yellowish brown to a reddish brown, the reddish brown, however, not attaining such a dark shade as in *nigrescens* or the infuscated effect of some individuals of the latter species. The pronotal carina, although usually distinct, is sometimes almost obsolete.

The female very closely resembles that of *nigrescens* and on superficial examination might easily be mistaken for the latter. From *nigrescens* it may be distinguished by the lack of the very prominent tuberculate or angulate posterior corners of the head; the smaller and more indistinct eyes; the less marginated prothorax; the somewhat shining head, which is distinctly less heavily sculptured than the thorax; the shorter pilosity; and the fainter longitudinal median groove on the mesonotum. Wheeler and Long (1901) furnish illustrations of the lateral and dorsal aspect of the female of *opacithorax* and also give a very brief but accurate description of the ant. Their description and figures were based on the specimen collected at Belmont, Gaston County, N.C., by P. J. Schmitt. This was the first female of *Neivamyrmex* to have been recognized and described in the United States. A female in the collection of the United States National Museum, bearing only the label "Texas," and which I refer to *opacithorax*, differs from my description in its smaller size, the almost straight anterior border of the clypeus, the lack of distinct sutures on the thorax, and its much deeper color.

The male of *opacithorax* can be distinguished by the following characters: Small eyes and ocelli; wide space between inner border of eye and lateral ocellus; weak ridge above antennal socket; somewhat slender, subfiliform funiculus; shining head and thorax; and bicolored body.

Males from different localities vary in shape of mandibles, color, sculpturing, and pilosity. The mandibles of some individuals are more slender than those of others. The apical slope of the mandible may also vary in length. The sculpturing on the head and thorax of some specimens is more pronounced than in others, thus imparting to these regions a dull cast, which, however, never entirely robs them of a somewhat slightly shining appearance. The color of the body may be dark in some specimens and light in others. The pilosity may range from a light yellowish or almost grayish to a deep golden yellow. The color of the gaster, although it may vary slightly, is always a light brown or reddish brown; whereas the gaster of *nigrescens*, though some-

times a deep blackish brown, is usually black. The male is most likely to be mistaken for that of *nigrescens*, from which it can be distinguished by its more slender, subfiliform funiculus; feebly developed ridge above antennal socket; more shining body, especially that of the head and thorax; bicolored body; smaller size; and more slender form. From the male of *carolinense* it can be distinguished by its larger size; more robust mandibles; larger eyes and ocelli; and less coarse body sculpture, especially that of the dorsum of the thorax and gaster.

In the eastern part of the United States *E. opacithorax* seems to have the same general range as *nigrescens*. My experience in the Gulf States indicates that it is never so abundant as the latter. Males have been collected from September through November.

ECITON (NEIVAMYRMEX) CALIFORNICUM Mayr

Eciton californicum Mayr, 1870, Verh. Zool.-Bot. Ges. Wien **20**: 969, ☿; Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**: 440; Dalla Torre, 1893, Cat. Hymen. **7**: 2; Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 28.

Eciton (Labidus) californicum Mayr, 1886, Wien. Ent. Zeit. **5**: 121, n. 14.

Eciton (Acamatus) californicum Emery, 1893, Bull. Soc. Ent. Ital. **26**: 184; Emery, 1895, Zool. Jahrb. Syst. **8**: 259; Emery, 1900, Mem. Real. Accad. Sci. Bologna **8**: 523; Emery, 1910, Gen. Insect., Fasc. **102**: 24.

Major worker.—Length 3-4 mm.

Head scarcely longer than broad; narrowed posteriorly; posterior border emarginate, forming produced, but blunt, angular corners. Eye rather small, ocelluslike, not easily discernible. Mandible of same general shape as that of *opacithorax*. Scape moderately robust, approximately three and two-tenths times as long at broad; when fully extended backward noticeably surpassing posterior border of eye; funiculus not especially robust. Frontal carina not forming a distinct flange in front of antennal socket as in *wheeleri* and *leonardi*. Thorax, from above, widest in region between fore coxae; promesonotum rather convex; a weak but distinct transverse carina on anterior part of prothorax. Epinotum clearly lower than mesonotum but not separated from it by a very distinct suture. Petiole, in profile, longer than high, convex above, with a blunt but definite anteroventral tooth. Postpetiole convex above, higher than long, highest posteriorly. Petiole, from above, slender, distinctly longer than broad, broadest posteriorly. Postpetiole subtrapezoidal, shorter but distinctly broader than petiole, and broader posteriorly than anteriorly.

Noticeably shining with the following exceptions: Mandibles, funiculi, meso- and metapleura, epinotum, petiole, and tarsi, which are slightly subopaque.

Mandibles striate-punctate; meso- and metapleura, epinotum, and petiole with granulate shagreening. Head with sparse, scattered punctures. Dorsum of thorax and petiole with scattered, foveolate punctures, best seen only in certain lights.

Pilosity yellowish, moderately abundant, of variable length, suberect to

erect. Antennal scapes, dorsum of body, ventral surface of gaster, and legs with sparse but very long, suberect to erect hairs.

Light to dark reddish brown, with distinctly lighter gaster.

Description based on workers collected at Sacramento by Sowell. The Sacramento specimens are considered typical because they agree very well with Mayr's description. Incidentally they were also collected near the type locality.

Type apparently in the Gustav Mayr collection of the Naturhistorisches Museum in Vienna.

Type locality.—San Francisco, Calif., H. Schaufuss.

Material studied.—CALIFORNIA: *Sacramento*, from house, Sowell, Calif. Dept. Agr. 36B71; *Palo Alto*, H. Heath.

I have examined specimens from Las Vegas, N. Mex., mentioned by Wheeler (1908). In my opinion these cannot be *californicum*. The broad petiole of the worker, if nothing else, would preclude this possibility. Forel (1914) described a variety *obscura* from specimens collected at *Vista*, southern California, by E. Hindle. I have examined a cotype worker and believe that Forel was incorrect in assigning his specimens to *californicum* because the mandible of the worker has not the characteristic shape of that of *californicum*.

The worker of *californicum* can be distinguished by the slender petiole, which is distinctly longer than broad; the straight margin on the superior border of the mandible, lying between the basal tooth and the masticatory border; the rather small, somewhat indistinct eyes; the frontal carina not forming a distinct flange in front of the antennal socket; the shining head, promesonotum, propleura, postpetiole, and gaster; the reddish-brown body with lighter gaster; and by the moderately abundant hairs of variable length, those on the scapes, dorsum of body, legs, and venter being unusually long and suberect to erect.

The worker can be distinguished from that of *opacithorax* by its more feebly sculptured and therefore more shining body, this being especially true of the promesonotum; generally longer and more erect hairs of the body; less distinct eyes; and usually lighter color. *Eciton opacithorax* was formerly considered a subspecies of *californicum* but was later raised to specific rank.

ECITON (NEIVAMYRMEX) WHEELERI Emery

Eciton wheeleri Emery, 1901, Bull. Soc. Ent. Ital. **33**: 55, fig. 8, ☿.

Eciton (Acamatus) wheeleri Emery, Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**:412; Emery, 1910, Gen. Insect., Fasc., **102**:25.

Eciton (Acamatus) wheeleri subsp. *dubia* Creighton, Creighton, 1932, Psyche **39**: 73, pl. 3, figs. 1, 2, 3, ☿, ♀. New synonymy.

Major worker.—Length 4-5 mm. (Pl. 1, Fig. 5).

Head slightly longer than broad, narrowest posteriorly; posterior border emarginate, forming well-produced, angular corners, which are strongly curved outwardly, especially in the smaller workers. Eye ocelluslike, very distinct.

Mandible similar to that of *carolinense* but often with the basal tooth less pronounced; small, irregular teeth on upper half of masticatory border also less distinct. Antennal scape clearly exceeding posterior border of eye; funiculus noticeably more slender than that of *carolinense*, this being especially true of segments 2 to 4 inclusive, which are about as broad as long. Frontal carina forming a broad, pellucid ring in front of antennal socket (this best seen from above). Promesonotum, in profile, convex but not strongly elevated posteriorly above base of epinotum, nor separated from epinotum by a pronounced dorsal constriction or suture. Pronotum with a very distinct transverse carina. Petiolar node robust, subquadrate; peduncle, in profile, with small but distinct antero-ventral tooth. Postpetiole clearly broader than petiole, broader than long, broadest posteriorly.

Head, propleura, legs, and gaster shining; promesonotum and dorsal surface of postpetiole often slightly shining; remainder of body subopaque. Head with scattered but distinct punctures. Dorsum of thorax, excepting the often shining promesonotum, subopaque; with foveolate punctures interspersed with reticulate shagreening. Petiole and postpetiole somewhat similarly but more feebly sculptured.

Hairs pale yellowish or grayish, long, suberect to erect, abundant, covering body and all appendages excepting funiculi.

Deep reddish brown; gaster and legs lighter.

Female.—Length 13.5 mm. (Pl. 2, Fig. 12).

Head subquadrate, with almost straight, subparallel sides, angular posterior corners, and broadly and rather deeply emarginate posterior border. Eye ocellus-like, fairly large and distinct but not so large or distinct as that of *nigrescens*. Mandible linear, superior border descending to meet inferior border in a long, oblique slope, which ends in an apical tooth. Scape curved, strongly enlarging toward apex, approximately one-half as long as head. Region adjacent and somewhat posterior to frontal area weakly protuberant anteriorly. A short, shallow, median groove running posteriorly from clypeus. External surface of clypeus concave, with middle of anterior border broadly and rather deeply excised. Dorsal surface of head, from above, with distinct median impression near occipital border but without a distinct impression on side of head anterior to each posterior corner; sides of head converging behind, giving this region an extended appearance, and forming very angulate posterior corners. Thorax elongate, approximately two and six-tenths times as long as broad, nearly uniform in width throughout, epinotum not distinctly wider than mesonotum as with females of *nigrescens* and *opacithorax*. Pronotum approximately as broad as long, convex above, lacking indications of lateral margins. Median longitudinal impression absent on mesonotum but present as a very shallow impression on epinotum. Posterior corners of epinotum not so broadly angular or distinct as in *nigrescens* and *opacithorax*. Thorax, in profile, approximately three and three-fourths times as long as high; mesonotum flattened; posterior part of epinotum convex, and slightly higher than any other part of thorax. Thoracic sutures absent dorsally. Petiole apparently as high as epinotum but

not so long; according to Creighton (1932) "ventrally the petiole is constricted to form a very thick, short, posterior peduncle and a much longer subtriangular portion which extends forward under the node and is narrowed in front to form the anterior peduncle." Petiole subquadrate, very slightly longer than broad, with rounded anterior angles, subparallel sides, and a shallow, dorsal impression, which is broader posteriorly than anteriorly.

Body and appendages shining except funiculi and tarsi. Head and thorax without the dense granulate shagreening between the numerous and distinct punctures.

Head, thorax, petiole, and appendages covered for most part with moderately abundant hairs; longer and less numerous hairs on mandibles, clypeus, edges of petiole, and appendages.

Rich reddish brown.

Description of worker based on 3 cotypes, and also on specimens from the several localities in Texas listed below. Description of female drawn from that caste of Creighton's *dubia*.

Cotypes in the Museum of Comparative Zoology.

Type locality.—Hays County, Tex., W. M. Wheeler.

Material studied.—TEXAS: Austin, W. M. Wheeler, ☿; Dallas, C. R. Jones, ☿; Victoria, J. D. Mitchell, ☿; 5 miles west of Fort Worth, Herbert Rücker, ♀ associated with ☿; Hillsboro, H. T. Vanderford, ☿; Port Lavaca, T. F. McGehee, ☿.

MEXICO: Guadalajara, J. F. McClendon, ☿.

The major worker of *wheeleri* is characterized by the strongly produced and often outwardly curved posterior corners of the head; the prominent, pellucid flange in front of the antennal socket; the rather slender antennal funiculus; the robust, subquadrate petiolar node; and the general dep reddish-brown color of body exclusive of gaster and legs. The sculpturing varies greatly on the thorax. Some specimens have the thorax almost entirely subopaque, others less so, and still others have it almost glabrous. There is a tendency for the smaller workers to have a more shining thoracic dorsum. Sometimes the shiny area includes all the dorsal surface. The smaller workers also seem to have more pronounced posterior corners to the head, and these corners have a more noticeable outward curve. The worker is likely to be confused with that of *carolinense* or *opacithorax*. For distinctions see the general discussion under *carolinense*.

The female can be readily identified by the very distinct, angulate, posterior corners of the head, anterior to which there is no impression on the side of the head; the elongate thorax, which is subequal in width throughout; the absence of dorsal sutures on the thorax; the absence of lateral margins on the prothorax, and of a median, longitudinal impression on the mesonotum; the almost square petiole; the shining body surface; and the rich reddish-brown color.

Not being able to detect any stable characters by which *dubia* can be separated from *wheeleri* I have synonymized the name *dubia*. The supposed sub-

species was described from workers and an associated female collected 5 miles west of Fort Worth by Herbert Rückes. The characters by which the workers of *dubia* were supposed to differ from those of *wheeleri* were the proportionally broader head with less-produced posterior corners and the more shining dorsal surfaces of the head and thorax. *Eciton harrisii* may possibly prove to be the male of wheeleri. If such should be the case then *wheeleri* would become a synonym. Although to date *wheeleri* has been collected only in Texas and Mexico, it will probably be found later in some of the adjoining States.

ECITON (NEIVAMYRMEX) CAROLINENSE Emery

Eciton (Acamatus) carolinense Emery, 1894, Bull. Soc. Ent. Ital. **26**: 184, ☿; Emery, 1895, Zool. Jahrb. Syst. **8**: 259, ☿; Emery, 1910, Gen. Insect., Fasc. **122**: 24; Wheeler, 1921, Proc. Amer. Acad. Arts and Sci. **56**: 314-315, fig. 8c, ♂.
Eciton carolinense Emery, Forel, 1899, Ann. Soc. Ent. Belg. **43**: 443, 447; ☿.

Major worker.—Length 3-4 mm.

Head scarcely longer than broad, narrowed posteriorly. Posterior corners of head, from above, feebly produced, bluntly angular and not outwardly curved as in *wheeleri*. Eye ocelluslike, distinct, but not large. Mandible constricted at base, then abruptly enlarging on its superior border to form an angular tooth, margin between tooth and masticatory border straight or feebly excised; masticatory border oblique, with three or four irregular teeth on its upper half. Scape robust, approximately three and one-third times as long as its greatest width; scarcely surpassing posterior border of eye; funiculus very noticeably incrassate, all segments except first and last clearly broader than long, last segment as long as combined length of two preceding segments. Frontal carina, from above, forming only a very narrow and indistinct flange in front of antennal socket. Pronotum without sharp transverse carina of *wheeleri*, but often with feeble indication of a carina when examined from proper direction. Promesonotum, in profile, forming a gently convex, continuous arch very slightly higher than base of epinotum; meso-epinotal suture shallow but distinct; base and declivity of epinotum subequal, the two surfaces meeting to form a bluntly rounded angle, closely approaching a right angle. Petiolar node robust, subquadrate, scarcely longer than broad (approximately five-sixths as broad as long). Peduncle with anteroventral tooth. Postpetiole shorter than petiole but broader; broader than long, broadest posteriorly.

Head, propleura, legs, dorsum of postpetiole, and gaster smooth and shining. Punctures on head sparse, scattered, distinct. Mandible with longitudinal striae in addition to coarse, scattered punctures. Thoracic dorsum subopaque, reticulately shagreened, reticulations interspersed with coarse, scattered, foveolate punctures; punctures seen better in some lights than in others. Meso- and metapleura subopaque, with coarse punctures. Petiole sculptured somewhat as thorax but more feebly so.

Hairs light yellowish or grayish, moderately abundant, of variable length, suberect to erect.

Yellowish brown to reddish brown, with head and thorax darker. Mandible usually darker than body.

Female.—Length 9-13 mm. (Pl. 2, Fig. 11).

Head approximately as long as broad, with gently convex sides, well-rounded posterior corners, and very indistinctly or not emarginate posterior border. Eye extremely small, indistinct, represented by a very pale spot. Mandible long, slender, acute at apex. Scape curved, robust, rather short, slightly less than half the length of the head. Region adjacent and also somewhat posterior to frontal area with a strong, transverse, angular protuberance. A longitudinal, median groove extending posteriorly from clypeus, much broadened above the angular protuberance and extending well back on vertex. External surface of clypeus at most weakly concave, middle of anterior border not deeply but distinctly excised. Dorsal surface of head, from above, lacking median impression anterior to the occipital border, and lateral impression on each side anterior to posterior corner as in *nigrescens;* head thus viewed, although emarginate behind, not having an extended appearance, and the posterior corners broadly and evenly rounded, not produced. Thorax, from above, approximately two and one-fifth times as long as broad; wider in proportion to its length than thorax of *opacithorax, wheeleri,* and *nigrescens.* Metanotum and epinotum subequal in width, distinctly wider than other areas of thorax. Promesonotal suture obsolete, mesometanotal and metaepinotal sutures fairly distinct. Pronotum convex, not perceptibly marginate anteriorly or laterally. Mesonotum lacking median, longitudinal impression. Epinotum wider than long, with rather distinct, median impression. Thorax, in profile, less than two and four-tenths times as long as high, highest and most convex dorsally in region of promesonotal suture, lowest or most depressed in vicinity of meta-epinotal suture. Petiole, in profile, higher than epinotum; with a prominent tooth beneath somewhat similar to that of *opacithorax* but smaller; distinctly broader than long, very slightly broader anteriorly than posteriorly, with very shallow and narrow median impression.

Body and appendages, except funiculi and tarsi, shining. Thorax with scattered, fairly distinct to distinct punctures; neither head nor thorax with dense granulate shagreening between punctures as in *opacithorax* and *nigrescens.*

Hairs on head, thorax, and petiole moderately abundant, short; longer on gula, mandibles, clypeus, scape, and legs.

Light yellowish brown to brown; gaster usually darker than head or thorax.

Male.—Length 9-9.25 mm. (Pl. 7, Fig. 22).

Head approximately one and eight-tenths times as broad as long; posterior border rounded but almost obscured by large transverse ridge above each antennal socket. Eye small, convex, not strongly protuberant. Ocelli remarkably small, placed on low protuberance, which is only slightly elevated above general surface of head; lateral ocellus far removed from eye, space between them as great as or greater than space between the lateral ocelli. Frontal carinae converging posteriorly, with distinct median groove between them, the groove interrupted above at level of frontal ridge. Scape approximately as long as first 3 funicular segments combined; funiculus subfiliform. Mandible remarkably elongate and slender, at least 5 times as long as broad, apex blunt. Head,

from above, well rounded behind eyes, with posterior corners blending into eyes; no occipital flange. A transverse groove behind the ridge above antennal socket. Eye, in profile, small, narrowed above, failing to occupy all of side of head, there being a small area dorsad and ventrad of eye and a much larger area posterodorsad; head behind ocelli convex. Thorax, in profile, approximately one and one-half times as long as high; slightly projecting anteriorly over head. Prothorax with a very distinct transverse impression anteriorly. Mesonotum with anteromedian and parapsidal lines. Epinotal declivity strongly concave. Legs slender. Tarsal claws weakly toothed. Petiole, from above, approximately one and one-half times as broad as long. Gaster slender, compressed. Paramere not characteristic enough to be clearly described.

Mandible with scattered but distinct punctures. Dorsal surface of head for the most part shining. Thorax with numerous coarse punctures, those of posterior part of mesonotum, scutellum, and sides of thorax largest and most distinct. Punctation of gaster coarse and dense enough to dull somewhat its luster and give gaster a rather subopaque appearance.

Hairs yellowish, dense, appressed; longest on head, appendages, sides and venter of thorax, petiole, and gaster.

Head, thorax, and petiole black; gaster deep reddish brown. Funiculi and tarsi lighter.

The description of the worker is based on cotypes and specimens from the localities mentioned below; that of the female on specimens from the six localities mentioned; that of the male from the specimen collected at Clayton, Ga., and the two males from Spartanburg, S.C.

Cotypes in collection of United States National Museum.

Type locality.—Belmont, Gaston County, N. C., P. J. Schmitt.

Material studied.—ALABAMA: Alabama City, L. C. Murphree, ♀; Butler, L. C. Murphree, ☿; Aliceville, L. C. Murphree, ☿; Jemison, L. C. Murphree, ☿. FLORIDA: Tallahassee, B. V. Travis, ☿; Leesburg, C. C. Goff, ☿; Madison, D. E. Read, ☿. GEORGIA: Columbus, H. T. Vanderford, ☿; Clayton, 6-?-09, 2,000-3,000 feet, W. T. Davis, ♂. KANSAS: Manhattan, J. W. McColloch, ♀. MISSISSIPPI: Aberdeen, M. R. Smith, ☿; State College, M. R. Smith, ☿; Meridian, M. L. Grimes, ☿; near Natchez, W. L. Gray, ☿; Columbus, M. R. Smith, ♀ associated with ☿. NORTH CAROLINA: Faison, A. Forel, ♀ associated with ☿; Jacksonville, M. R. Smith, ♀ associated with ☿. SOUTH CAROLINA: Spartanburg, 5-27-32; D. E. Read, ☿, ♀, ♂. TENNESSEE: Gatlinburg, Mary Talbot, ☿; Greenbrier Cove, Great Smoky Mountain National Park, Mary Talbot, ☿; Cades Cove, Great Smoky Mountain National Park, A. C. Cole, Jr., ♀ associated with ☿.

The major worker can be distinguished by its short and strongly incrassated funiculus; feebly produced, posterior corners of the head; subquadrate petiolar node; and by its feebly developed or apparently missing pronotal carina. The major worker is likely to be confused with that of *wheeleri* or *opacithorax*. From the former it may be distinguished by the lack of the strongly produced, sharply angular, outwardly curved posterior corners of the head; the absence of a broad flange in front of the antennal socket, and the absence of a well-defined pronotal carina. In addition to the characters mentioned *carolinense*

is also distinguished by its lighter color and different distribution. *Eciton carolinense* seems to be confined mostly, if not altogether, to the region east of the Mississippi River, especially the Gulf Coast and Southeastern States, whereas *wheeleri* is confined to Texas, Mexico, and possibly some of the other Southwestern States. Although the thorax is distinctly sculptured and subopaque in the larger workers, this is not true of the smaller workers, which often have the thorax entirely or in part glabrous. From *opacithorax* the major worker can be distinguished by its robust, subquadrate petiole; short and much incrassated funiculus; and by the blunt, feebly produced posterior corners of the head.

Forel (1899) was the first person to recognize and briefly describe the female. Although females have been collected on numerous occasions, no one has taken the trouble to give a detailed and adequate description of this caste.

The female of *carolinense* can be distinguished by her very small, indistinct eyes; her lack of a median impression on the vertex near the occiput, and a lateral impression on each side of the head anterior to the posterior corner; by having the thorax more robust than that of *opacithorax* and *nigrescens* with the metanotum and epinotum subequal in width, and wider than the rest of the thorax. The female is also characterized by her light yellowish-brown color, shining body, by the absence of definite lateral margins on the prothorax, and by the lack of a median longitudinal impression on the mesonotum. The specimens vary considerably with respect to size, color, sculpture, pilosity, shape of mandible, size and prominence of angular protuberance on the dorsal surface of the head, and the development of the impression above the protuberance, proportions of thorax, and size and shape of petiole. The punctures on the thorax are much coarser and more prominent on some individuals than on others. The pilosity, although generally short, is sometimes fairly long and more erect. The mandible is normally elongate, narrow, with rather acute tooth; but some individuals have a broader and shorter mandible with less acute tooth. The angular protuberance on the dorsal surface of the head is usually very strongly developed. The impression back of this protuberance is usually broad and distinct, but on some specimens it is so shallow and narrow as to be scarcely noticed. The thoracic proportions vary considerably, the length ranging from approximately twice the width to two and four-tenths times the width. The ventral tooth of the petiole ranges from small to large, but is smaller and usually more angular than that of *opacithorax* and *nigrescens*.

The male can be distinguished by its very small eyes and ocelli; remarkably long, slender mandibles; large space between each eye and lateral ocellus; prominent transverse ridge above each antennal socket; somewhat bicolored body; and the densely and coarsely punctured head and thorax, which have an opaque appearance. The male might be mistaken for that of *opacithorax*. For distinctions see the discussion under *opacithorax*.

Males have been collected too infrequently to enable one to determine the months in which they are most abundant.

ECITON (NEIVAMYRMEX) COMMUTATUM Emery

Eciton nitens Mayr (part), Mayr, 1886, Wien. Ent. Zeit. **5**: 121.

Eciton (Acamatus) commutatum Emery, 1900, Mem. Real Accad. Sci. Bologna **8**: 522, ☿; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 413; Emery, 1910, Gen. Insect., Fasc. **122**: 24.

Major worker.—Length 4-5 mm. (Pl. 1, Fig. 6).

Eye extremely small, indistinct, apparently placed beneath general surface of head, and only observable after careful examination. Superior border of mandible with remarkably large, blunt, angular, basal tooth; margin deeply excised between this tooth and masticatory border; masticatory border usually with a number of small, irregular teeth, which may often be worn off. Antennal scape remarkably robust, short, less than three times as long as its greatest width; funiculus exceedingly short and broad, all segments, except first two and last, very noticeably broader than long. Antennal socket open in front, that is, without a flange (this best seen from above). Posterior border of head, from above, deeply emarginate, forming distinct, blunt, angular posterior corners; posterior corners not outwardly curved as in *wheeleri*. Thorax compressed. Pronotum without transverse carina. Promesonotum approximately two and a half times length of epinotum when measured from the point where the carina should be back to meso-epinotal suture; meso-epinotal suture broad, distinct, but not deep. Anterior half of promesonotum, in profile, convex; posterior half distinctly flattened; posterior part of promesonotum clearly elevated above base of epinotum. Base of epinotum meeting declivity in blunt, obtuse angle, which in some aspects does not appear much greater than a right angle. Petiole robust, subquadrate, approximately seven-eighths as broad as long. Postpetiole scarcely shorter than petiole but very clearly broader, approximately one and one-fourth times as broad as long, broader posteriorly than anteriorly.

Body and appendages unusually smooth and highly polished, with the following exceptions: Mandibles subopaque, coarsely and longitudinally striated, and bearing scattered piligerous punctures near the masticatory border; anterior declivity of pronotum, propleura, and sides of petiole and postpetiole faintly shagreened, subopaque; meso- and metapleura more coarsely granulate-punctate; meso-epinotal suture granulate-punctate, with also longitudinal striae; tarsi and funiculi opaque owing to the abundant pile. Head with small, scattered, but distinct punctures.

Hairs yellowish, moderately abundant, of variable length, apparently sparse or absent on sides of thorax and head. Appressed pubescence more visible on gaster than elsewhere.

Deep yellowish brown to reddish brown, with lighter petiole, post-petiole, gaster, and legs; mandibles and frontal carinae much darker, especailly around borders.

Cotypes presumably in collection of C. Emery, which is now under the care of C. Menozzi, of Chiavari, Italy.

Type locality.—New Granada.

Material studied.—ARIZONA: Phoenix. TEXAS: Victoria, L. C. Murphree; New Braunfels, R. A. Cushman; San Augustine, E. S. Tucker; Austin, W. M. Wheeler.

The major worker of *commutatum* can be distinguished by the shape of the mandibles and petiole; feebly developed, indistinct eyes; short, heavily incrassated antenna; the compressed and somewhat depressd thorax; broad but shallow meso-epinotal suture; obtusely angular epinotum; smooth, highly polished, shining body, with the exception of certain parts; and the absence of a flange in front of the antennal socket. This species is likely to be confused with *carolinense*, as the major workers of the two species have somewhat similarly shaped petioles, postpetioles, and antennae. The major worker of *commutatum* can be distinguished from that of *carolinense* by its compressed, dorsally flattened thorax, the dorsum of which is highly polished, smooth, and shining, and lacking the coarse foveolate punctures of *carolinense;* by its more feebly developed eyes; its distinctly shorter and more incrassated antenna; and less dense pilosity.

Our present knowledge seems to indicate that *carolinense* is a Gulf coast and Southeastern form, ranging from Florida into North Carolina and westward into Mississippi, Tennessee, and Kansas. *Eciton commutatum*, on the other hand, is apparently a Southwestern ant. The range of neither species, especially of *commutatum*, is as well known as it should be.

ECITON (NEIVAMYRMEX) PAUXILLUM Wheeler

Eciton (Acamatus) pauxillum Wheeler, Wheeler, 1903, Psyche **10**: 93, fig. 1, ☿; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 412. Emery, 1910, Gen. Insect., Fasc. **102**: 25.

Worker.—Length 1.75-2 mm. (Pl. 1, Fig. 8).

Head approximately one and one-third times as long as broad, widest anteriorly; with feebly convex, but pronounced, posteriorly converging sides. Eyes apparently absent. Mandible with a prominent, acute tooth on superior border, approximately two-thirds distance between base and masticatory border. Antenna very short, robust; scape approximately three times as long as its greatest width, extending posteriorly about one-half length of head; funiculus heavily incrassated, all segments except first and last as broad as long, or broader than long. Frontal carina not forming a distinct flange in front of antennal socket as with *wheeleri;* the apparent flange narrow, not noticeably upturned (best seen from above). Posterior border of head, from above, emarginate, forming feebly produced, blunt corners. Thorax compressed. Pronotum without any evidence of transverse carina. Dorsum of thorax, in profile, rather flat, meso-epinotal suture so feebly defined that the posterior part of the mesonotum and the base of the epinotum appear as an almost continuous surface in about the same plane; base of epinotum meeting declivity in a fairly pronounced, obtuse angle. Petiole, from above, rather robust, subquadrate, approximately one-fifth longer than broad. Postpetiole shorter but

broader than petiole, ellipsoidal, distinctly broader than long. Peduncle of petiole with rounded and very blunt, anteroventral protuberance. Gaster strikingly elongate elliptical, distinctly depressed.

Body and appendages polished and shining, with the following exceptions: Mandibles, funiculi, the faintly shagreened meso- and metapleura, ventral surfaces of petiole and postpetiole, and tarsi. Mandibles, head, and thorax with scattered piligerous punctures.

Body and appendages with moderately abundant, rather long, yellowish, suberect to erect hairs.

Light yellowish brown with edges of clypeus, mandibles, articulations of legs, petiole, and postpetiole darker.

Description drawn from four cotype workers, three from the American Museum of Natural History and one from the Museum of Comparative Zoology.

Cotypes in the Museum of Comparative Zoology and the American Museum of Natural History.

Type locality.—Austin, Tex., W. M. Wheeler.

Also recorded by Wheeler (1908) from Paisano Pass near Alpine, Tex. I have not seen these specimens.

The worker of *pauxillum* can be readily identified by the form of the head and the shape of the mandible; by its very short, robust antenna; by its subquadrate petiole; by its elongate, elliptical, depressed gaster; by its very small size; and by its lack of a pronotal carina.

I cannot agree with the statement in Wheeler's original description that the head of the worker, including the mandibles, is "fully twice as long as broad," nor can I agree with another statement that the "petiole and postpetiole whether seen from above or in profile are of similar size and form."

This is the smallest known species of *Eciton* in the United States. The very slight difference in the size of the workers is noteworthy, however. It is possible that Wheeler failed to secure major workers. All species of *Eciton (Neivamyrmex),* as far as I am aware, are noted for the pronounced polymorphism of their workers.

The specimens collected by Wheeler at Austin, Tex., were taken from the soil beneath a stone. The species is probably more hypogaeic than some of the other members of the subgenus.

ECITON (NEIVAMYRMEX) LEONARDI Wheeler

Eciton (Acamatus) leonardi Wheeler, 1915, Bull. Amer. Mus. Nat. Hist. **34**: 392. ☿.

Worker.—Length 2-3 mm.

Head slightly longer than broad; a little broader anteriorly than posteriorly, with emarginate posterior border and moderately convex sides. Eye apparently absent. Superior border of mandible with basal tooth and an excised margin between this tooth and masticatory border, the excised margin sometimes with

a few very small, irregular denticulae; masticatory border with a long apical and two shorter teeth. Antennal scape fairly robust, short, attaining approximately one-half length of head; all segments of funiculus except first and last as broad as or broader than long. Frontal carina forming a broad, pellucid flange in front of antennal socket. Posterior corners of head, from above, feebly produced, bluntly angular. Thorax, from above, with a distinct constriction on each side of meso-epinotal region. Pronotum without any evident transverse carina. Dorsum of thorax weakly convex; promesonotum feebly elevated above epinotum, meso-epinotal suture feebly developed. Petiole and postpetiole each with a ventral toothlike projection. Petiole subquadrate, approximately one and one-fourth times as long as broad. Postpetiole slightly shorter, but distinctly broader, than petiole; approximately two-thirds as long as broad, subtrapezoidal. Gaster oval.

Body and appendages smooth and shining with the following exceptions: Mandibles, funiculi, meso- and matapleura, meso-epinotal constriction, tarsi, and ventral surfaces and sides of petiole and postpetiole, subopaque; mandibles coarsely striate-punctate; all areas faintly shagreened except funiculi and tarsi. Head with sparse but definite punctures.

Hairs pale yellowish, moderately long, and moderately abundant, suberect to erect.

Light yellowish brown with darker clypeal region and mandibles.

The description is based on a single cotype specimen from the Museum of Comparative Zoology.

Cotypes in Museum of Comparative Zoology.

Type locality.—Point Loma, near San Diego, Calif., Percy Leonard.

The worker of *leonardi* can be distinguished by the short scape; broad flange in front of antennal socket; shape of mandible; subrectangular petiole; smooth and shining body with the exception of certain parts; and its light yellowish-brown color. It is also characterized by the apparent absence of eyes, and by the lack of a pronotal carina.

The worker of this very small species is most closely related to that of *pauxillum,* from which it can be distinguished by its shorter and more robust head, the posterior region of which is not so noticeably constricted as that of *pauxillum;* by the presence of a broad, distinct flange in front of the antennal socket; its larger size; and by the lack of a distinctly flattened gaster. Furthermore, *leonardi* has been collected only in the southern part of California whereas *pauxillum* has been found only in central and southwestern Texas.

Mann's *peninsulare* is very close to if not identical with *leonardi,* but with only one specimen of *leonardi* to compare with Mann's series of specimens it is difficult to determine whether the two species are identical. Wheeler described *leonardi* from only three workers. There is the possibility that *leonardi* has larger (major) workers, which were overlooked at the time of collection.

ECITON (NEIVAMYRMEX) HARRISII (Haldeman)

Labidus harrisii Haldeman, 1852, Stansbury's Expedt. Great Salt Lake. Lippincott, Grambo and Co. Publr., p. 367, pl. 9, figs. 4, 5, 6, ♂; Cresson, 1872, Trans. Amer. Ent. Soc. **4**: 194.

Eciton (Labidus) harrisi (Haldeman), Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**: 441; Emery, 1895, Zool. Jahrb. Syst. **8**: 261; Wheeler and Long, 1901, Amer. Nat. **35**: 165, fig. 2a.

Eciton harrisii (Haldeman), Dalla Torre, 1893, Cat. Hymen. **7**: 3.

Eciton harrisi (Haldeman), Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 28.

Eciton (Acamatus) harrisi (Haldeman), Emery, 1900, Mem. Real. Accad. Sci. Bologna **8**: 515, fig. 18; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 413, pl. 26, fig. 10; Emery, 1910, Gen. Insect., Fasc. **102**: 26.

Male.—Length 10.5 mm. (Pl. 6, Fig. 21).

Head approximately one and three-fourths times as broad as long. Eye remarkably large, convex, protuberant. Ocelli large, placed on protuberance well elevated above general surface of head. Frontal carinae subparallel medianally, usually with a weak groove between them. Ridge above antennal socket prominent, most distinct from above. Antennal scape approximately as long as combined length of first 3 funicular segments; funiculus broadest near base, gradually narrowing toward apex. Mandible robust, with convex inferior and somewhat straight superior border, the two borders subparallel in basal half and tapering in apical half to form a blunt point. The large, protuberant eye, in profile, occupies all of the side of the head except a very narrow area above the base of the mandible, and a larger space posterodorsad of the eye. Thorax slender. Anterior surface of prothorax, in profile, with a transverse impression. Epinotum subtruncate or weakly concave. Tarsal claws feebly or nontoothed. Petiole small; about one and one-half times as broad as long, with rounded, weakly defined posterior corners. Gaster slender, with distinct but not very strong constrictions between segments. Intermediate tooth of seventh gastric sternum short but distinct. A weak transverse impression near base of sixth gastric tergum. Lower part of aedeagus terminating in a pair of processes, which when viewed from a posterior direction resemble very much a hand with only the index finger extended.

Mandibles, head, and thorax with small but distinct punctures, well scattered on side of thorax, more dense on dorsum. Anterior border of each gastric segment smooth. Body and appendages, except funiculi, shining in some lights.

Pilosity yellowish, rather abundant; longest on mandibles, antennal scapes, head, legs, sides and venter of thorax, venter of petiole, and gaster; more appressed elsewhere. Seventh gastric sternum rather densely pilose.

Light to dark brown, with dorsal surfaces of head, thorax, and petiole darker. Wings pale, with weak grayish or yellowish cast; veins and stigma light brown to dark brown.

Description drawn from numerous specimens from the localities listed below.

Type apparently lost.

Type locality.—Fort Gates, Coryell County, Tex., Lieut. Horace Haldeman. For remarks concerning the correct type locality see discussion under *melsheimeri*.

Material studied.—ARIZONA: Nogales, 6-13-03, 6-25-03, 6-31-03, 7-18-03, E. J. Oslar; Fort Grant, 7-19-?, 7-22-?, 7-23-?, in Hubbard collection. NEW MEXICO: Mesilla, 7-30-?, T. D. A. Cockerell; Pyramid Peak, Dona Anna County, 7-23-30, F. R. Fosberg. OKLAHOMA: Stillwater, 9-18-37, F. D. Miner. TEXAS: Wharton, 6-24-17, in Cornell University collection; Columbus 8-?-17; Dallas, 8-20-07, W. W. Yothers; Dallas, 7-21-06, W. A. Hooker; Plano, 8-?-?, E. S. Tucker; Cypress Mills, in W. H. Ashmead collection; Kerrville, 8-14-06, 8-26-06, F. C. Pratt; Burleson, 8-24-03, in Texas Agricultural and Mechanical College collection; Winter Haven, 7-17-35; S. E. Jones; Rock Island, 6-29-22, G. O. Wiley; Trinity, 8-30-06, F. C. Bishopp; Bryan, 7-10-37, in Texas Agricultural and Mechanical College; College Station, 9-1-35, 9-9-35, 9-11-35, 10-6-28, 10-7-28, 10-30-28, in Texas Agricultural and Mechanical College collection; Taylor, 7-26-33, J. E. Gillaspy; Colorado County, 7-25-22, G. O. Wiley; Eastland County, 8-6-21, G. O. Wiley; Port Lavaca, F. D. Miner; Temple, C. F. Maxwell; Bastrop County, 7-20-37; Richmond, 6-22-17; Bastrop, Heiligbrodt; Victoria, 7-21-16, 7-31-16, 8-22-12, 9-6-15, J. D. Mitchell; Brownsville, 7-27-?, 8-1-?, 8-2-?, 8-15-?, in Brooklyn Museum collection; Brownsville, 6-?-04, H. S. Barber; Brownsville, 7-16-16, R. A. Vickery; Brownsville, 7-30-?, 6-19-08, 6-21-08, D. K. McMillan; Brownsville, 9-30-06, J. C. Crawford; South Texas Gardens, 6-21-08, 6-22-08, 6-23-08.

MEXICO: Tlahualilo, 7-?-05, A. W. Morrill; Buena Vista, Sierra del Carmen, Coahuila, 7,000 feet, R. H. Baker; Colima, L. Conrad.

Wheeler (1908) lists *harrisii* from Austin, Waco, and Brownsville, Tex.; Mesilla, N. Mex.; Palmerlee and Nogales, Ariz.; and Sinaloa, Mexico.

The male of *harrisii* is distinguished from those of other species by its form and color; very large eyes and ocelli; prominent ridge above antennal socket; shape of mandible; transverse impression on prothorax and also on base of sixth gastric tergum; shape of aedeagus; and nature of punctation.

Although this species is very easy to distinguish by the characters mentioned above, I have found considerable variation among different individuals. Such variation includes depth of color; length and abundance of hairs; size of eyes; amount of development of transverse ridge above antennal socket; width betwen frontal carinae; shape of mandibles; and coarseness of punctures.

Males of *nigrescens* and *opacithorax* have mandibles which considerably resemble those of *harrisii* but these species can easily be distinguished from *harrisii* by their much smaller eyes and ocelli; different body color, and other characters. I am not aware of any species of *Eciton* in the United States the male of which has a more distinctive appearance than *harrissii*.

Although this species has been collected in Arizona, New Mexico, Oklahoma, and Mexico, it seems to be most common in Texas, especially in the eastern half of the State. The color of the body of the male, the nature of the sculpturing and pilosity, and the distribution of the ant in Texas strongly suggest that this may be the male of *wheeleri*.

Males have been collected from June to October inclusive; however, they seem to be most common during June and July.

ECITON (NEIVAMYRMEX) MINUS (Cresson)

Labidus minor Cresson, 1872, Trans. Amer. Ent. Soc. **4**:195, ♂; Cresson, 1887, Trans. Amer. Ent. Soc. suppl. vol., p. 259.

Eciton (Labidus) minor (Cresson), Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**:441.

Eciton (Labidus) minus (Cresson), Emery, 1895, Zool. Jahrb. Syst. **8**:261; Wheeler and Long, 1901, Amer. Nat. **35**: 165.

Eciton minus (Cresson), Dalla Torre, 1893, Cat. Hymen. **7**: 4; Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 29.

Eciton (Acamatus) minus (Cresson), Emery, 1900, Mem. Real Accad. Sci. Bologna **8**: 516; Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 418, pl. 26, fig. 6; Emery, 1910, Gen. Insect., Fasc. **102**: 27.

Male.—Length 8.75 mm. (Pl. 4, Fig. 17).

Head approximately one and seven-tenths times as broad as long. Eye large, convex, protuberant. Ocelli rather large, placed on protuberance above general surface of head; summit of protuberance concave; lateral ocellus usually about one-half its greatest diameter from inner border of eye. Frontal carinae subparallel or faintly divergent posteriorly, with groove between them extending to anterior ocellus. Antennal scape robust, longer than combined length of first 3 funicular segments, but not so long as combined length of first 4 segments; segments 1 and 2 distinctly broader than long, segments 3 to 5 inclusive feebly enlarged, segments 4 to 12 inclusive clearly longer than broad. Posterior corners of head not angularly protuberant as in *fuscipennis* and *melsheimeri*. Mandible moderately long, curved, gradually tapering from base toward apex, where it ends in an extremely acute, incurved point; shorter and more robust than in the two species mentioned above. Head, from above, weakly projecting behind eyes, more rounded immediately behind and adjacent to eyes than in *fuscipennis* and *melsheimeri*. Eye occupying approximately all of side of head except the produced and feebly ridged corner posterodorsad of eye. Region of head behind ocelli, in profile, flattened or feebly concave. Occipital flange lacking. Thorax longer than high, proportionally higher than in *melsheimeri;* somewhat projecting above head. Mesonotum convex, with anteromedian and parapsidal lines, these distinct in some specimens, less distinct in others. Epinotum, in profile, subtruncate or feebly concave. Legs remarkably small. Sides sharply margined through anterior half of petiole. Tarsal claws feebly toothed. Gaster slender, compressed, with distinct constrictions between segments. Sixth gastric tergum with a transverse impression near base. Seventh gastric sternum with two acute lateral teeth, and a less acute intermediate tooth. Paramere short, but abruptly enlarged apically to form a blunt, somewhat spear-shaped structure.

Head shining; thorax and gaster more subopaque owing to the dense, short, and closely appressed hairs; thorax more subopaque than gaster. Punctation more or less concealed by the pubescence, coarsest on posterior part of mesonotum and pleura.

Hairs yellowish, short, dense, much appressed on all parts of body; longer and suberect to erect on head, scapes, and ventral surface of body; hairs on head less dense than on appendages.

Brown; head darkest, thorax less dark, and gaster least dark of all. Wings very pale, semitransparent, with extremely light veins and distinct brown stigma.

The foregoing description is based on the lectotype in the Academy of Natural Sciences of Philadelphia and the six paratypes in the United States National Museum.

Type locality.—Bosque County, Tex., G. W. Belfrage.

Material studied.—ARIZONA: Fort Grant, 7-19-?, 7-23-?, 7-22-?, Hubbard; Globe, 8-8-35, F. H. Parker. CALIFORNIA: Ramona, 8-15-14, J. C. Bradley; Claremont, C. F. Baker; Riverside, 8-5-24, 8-6-24, 8-10-24, P. H. Timberlake; Monrovia, 8-?-?, Jack Schwartz; Alhambra, 7-?-38, Jack Schwartz; San Diego, Ricksecker; Pasadena, 8-10-08, F. Grinnell, Jr.; San Gabriel, 4-1-10, H. J. Quayle; San Jacinto, 6-?-?; Boquet Canyon, Los Angeles County, 8-17-37, N. Westerland. KANSAS: Northeast corner of Barber County, 7-25-33. NEW MEXICO: Mesilla Park, 7-12-17. OKLAHOMA: Stillwater, 8-3-38, R. W. Kaiser. TEXAS: Plano, 7-?-?, E. S. Tucker; Brewster County, Chisos Mountains, 6-10-08, 6-12-08, J. D. Mitchell and R. A. Cushman; Nolan County, 7-4-37; Daingerfield, 7-9-37; Edinburg, ?-?-35, S. Mulaik; Limpia Canyon, Davis Mountains, 7-17-17, in Cornell University collection.

MEXICO: Five miles south of Miraflores, 7-10-38; San Miguel, 7-3-38; 15 miles west of La Paz, 7-5-38; 12 miles south of Santa Rosalia, 6-27-38; Buena Vista, Sierra del Carmen, Coahuila, 6,000 feet, 7-7-38, R. H. Baker; 3 miles north of San Pedro, 7-6-38; San Domingo, 7-19-38; Coyote Canyon, Concepcion Bay, 6-29-38. All the Mexican collections were made by Michelbacher and Ross except as noted.

The male of *minus* can be distinguished from those of other species by its small size and slender form; by the shape of the mandibles; by the posterior corner of the head not being strongly protuberant between the eye and the lateral ocellus; by the shape and length of the antennal scapes; by the flat or feebly concave area of the head back of the ocelli; by the lack of an occipital flange; by the nature of the pilosity; and by the color of the body and wings.

The male is more variable than that of *melsheimeri*. Such variation includes width of space between eye and lateral ocellus; production of head behind eyes; distinctness of lines on mesonotum; color (light brown to deep brown with the head black on some individuals and scarcely darkened on others); length of pilosity; and coarseness of punctation. Specimens from Mexico are much more robust, deeply colored, and coarsely punctured than are the specimens from Texas northward.

The male of *minus* is most likely to be confused with that of *melsheimeri* and *fuscipennis*. It differs from both these species in lacking the prominent posterior corners of the head. It can be distinguished from the former by the absence of long, suberect to erect hairs on the thorax and gaster; and from the latter by its much paler, semitransparent wings.

The species has a wide range in the southwestern part of the United States and extends southward into at least Mexico. Males have been collected from April through August, but more commonly during July and August.

ECITON (NEIVAMYRMEX) MELSHEIMERI (Haldeman)

Labidus melshaemeri Haldeman, 1852, Stansbury's Expedt. Great Salt Lake. Lippincott Grambo and Co., Publr., p. 368, pl. 9, figs. 7, 8, 9, ♂; Cresson, 1887, Trans. Amer. Ent. Soc. suppl. vol., p. 259.

Eciton (Labidus) melshaemeri (Haldeman), Mayr, 1886, Verh. Zool.-Bot. Ges. Wien **36**: 442; Emery, 1895, Zool. Jahrb. Syst. **8**: 261; Wheeler and Long, 1901, Amer. Nat. **35**: 165.

Eciton melshaemeri (Haldeman), 1893, Dalla Torre, Cat. Hymen. **7**: 4; Emery, 1900, Mem. Real Accad. Sci. Bologna **8**: 516.

Eciton melsheimeri (Haldeman), Forel, 1899, Biol. Centr.-Amer., Hymen. **3**: 28.

Eciton (Acamatus) melsheimeri (Haldeman), Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 418, pl. 26, fig. 9.

Eciton (Acamatus) melshaemeri (Haldeman), Emery, 1910, Gen. Insect., Fasc. **102**: 26.

Male.—Length 7 mm. (Pl. 4, Fig. 16).

Head approximately one and six-tenths times as broad as long. Eye prominent, convex, protuberant. Ocelli large; ocellar protuberance concave at summit, inner border of eye and lateral ocellus almost touching each other. Frontal carinae sharply margined, subparallel, with distinct groove between them up to point where each converges outwardly toward eye, thus forming a prominent ridge above each antennal socket. Antennal scape robust, short, approximately as long as combined length of first 3 funicular segments; second funicular segment unusually short, third through fifth distinctly broader than any succeeding segments. A pair of short, stubby, toothlike projections posterior to clypeus, these not evident on all individuals. Mandible rather long, slender, curved, tapering from base toward apex, where it ends in a very acute point. Posterior corner of head strongly projecting between lateral ocellus and inner border of eye, but not so well developed as in *fuscipennis*. From above, posterior corners of head projecting behind and also dorsolaterad of eye, thus giving head an extended appearance. In profile, vertex and posterior corner of head well extended dorsally above superior border of eye. Eye nearly touching base of mandible, occupying all of side of head except for large, protuberant, ridge-shaped corner posterodorsad of eye. Region of head posterior to ocelli, in profile, flattened or feebly concave; occiput without a perceptible flange. Thorax, in profile, distinctly longer than high, not projecting perceptibly above head. Anterior median and parapsidal lines often indistinct or missing, the former most easily seen. Epinotum, in profile, subtruncate. Tarsal claws faintly toothed. Petiole, in profile, flattened or feebly convex beneath. Gaster elongate, slender, compressed, with distinct constrictions between segments. Intermediate tooth on apex of seventh gastric sternum small and indistinct, the lateral teeth acute. In profile, apex of paramere truncate, ventral border of apex convex, and dorsal border of apex excised.

Body rather shining in spite of the unusually long and fairly dense hairs covering it. Punctures on side of thorax sparse, but visible in some lights.

Hairs yellowish, long, suberect; less appressed on head, thorax, petiole, and ventral surface of gaster; unusually long near apex of gaster.

Yellowish brown to darker brown with the head usually, and the thorax occasionally, darker than remainder of body. Wings dusky grayish or dusky yellowish, with light-brown veins and distinct dark stigma.

The description is based on numerous specimens from the localities cited below.

Type apparently lost.

Type locality.—Fort Gates, Coryell County, Tex., Lieut. Horace Haldeman.

The type locality of this species has been incorrectly cited by many formicologists as Fort Gates, Utah, because *melsheimeri* was described by Prof. S. S. Haldeman in the report of Stansbury's Expedition to the Great Salt Lake (Haldeman, 1852). Since not all the insects mentioned or described in this report were collected in Utah, and as *melsheimeri* is common in Texas (no one has ever reported it from Utah), I believe the Fort Gates referred to is unquestionably that in Coryell County, Tex. What applies to the type locality of *melsheimeri* also applies to the type locality of *harrisii*.

Material studied.—OKLAHOMA: Latimer County, W. Fisher. TEXAS: Brownsville, 5-21-04, 6-?-04, 6-5-04, H. S. Barber; Brownsville, 5-?-?, 6-?-?, in Brooklyn Museum collection; Brownsville, 4-28-11, 5-19-11, R. A. Vickery; Brownsville, 6-?-?, in Cornell University collection; Wharton, 6-24-17, in Cornell University collection; Victoria, 6-24-17, in Cornell University collection; New Braunfels, 6-26-17, in Cornell University collection; Winter Haven, 5-15-36, 5-23-36, S. E. Jones; Mexia, 6-23-37, Texas State Park Survey; Daingerfield, 7-6-37, in Texas Agricultural Experiment Station collection; Morris County, 6-23-37, in Texas Agricultural Experiment Station collection; Plano, 8-?-?, E. S. Tucker; Richmond, 6-22-17, in Cornell University collection; Columbus; College Station, 6-11-33, H. J. Reinhard; Dallas, 7-8-06, J. C. Crawford; Wellborn, 6-29-37, R. W. Strandtmann.

MEXICO: Paso de Talaya, Vera Cruz, C. H. T. Townsend.

Wheeler (1908) cites *melsheimeri* from Austin, Brownsville, Plano, and Dallas, Tex., and from Paso de Telaya, Vera Cruz, Mexico. He states, "This species is common at Austin about the electric lights during the spring and summer months. It ranges as far south as Guatemala and Costa Rica."

The male can be distinguished from males of other species by its small size and slender form; shape of mandibles; strongly protuberant posterior corner of head; very narrow space between eye and lateral ocellus; flattened or faintly concave surface of head back of ocelli; absence of any perceptible occipital flange; and nature of pilosity and color.

There seems to be less variation in the males of *melsheimeri* than in the males of some of the other species of *Eciton* discussed in this article. The characters observed to vary most are the length of the pilosity and its degree of erectness; the color of the body; the distinctness of the anteromedian and parapsidal lines on the mesonotum; the development of the concavity at the summit of the ocellar protuberance; the depth of the groove between the frontal carinae; and the development of the tooth on the tarsal claws.

The male of *melsheimeri* might be confused with that of *minus*. It can be readily distinguished, however, by the presence of the prominent, protuberant

posterior corners of the head, and the longer and more erect body hairs, especially those of the gaster.

Males have been collected from April to August inclusive, most of them having been taken during June. They are apparently among the earliest males of *Eciton* to appear.

ECITON (NEIVAMYRMEX) FUSCIPENNIS Wheeler

Eciton (Acamatus) spoliator Wheeler (not Forel), 1908, Bull. Amer. Mus. Nat. Hist. **24**: 416, pl. 26, fig. 12, ♂.

Acamatus fuscipennis Cresson, Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 417, pl. 26, fig. 12, ♂.

Male.—Length 10 mm. (Pl. 4, Fig. 15).

Head one and six-tenths to one and seven-tenths times as broad as long; posterior corners strongly protruding and easily visible between lateral ocellus and eye. Ocelli large, but not placed on high protuberance above general surface of head as in *minus*, summit of protuberance concave. Antennal scape approximately as long as the combined length of the first 3 funicular segments; funiculus of approximately same width throughout, except through segments 2 to 5 inclusive, where it is feebly broader; segments 3 to 12 distinctly longer than broad. Mandible remarkably long, slender, curved, tapering from base toward apex and ending in a very acute point. Frontal carinae rather far apart, with moderately shallow but broad groove between them. Eye rather large, convex, protuberant. In profile, eye occupying all of side of head except small area above base of mandible and a large ridgelike area posterodorsad of eye. In profile, region of head posterior to ocelli flattened or feebly concave, lacking occipital flange. From above, posterior corners projecting noticeably behind eyes. Space between ocellus and eye approximately equal to one-half or less greatest diameter of ocellus. In profile, thorax not noticeably protruding above head as in *minus*. Prothorax without distinct transverse impression anteriorly. In profile, thorax about three-fifths as high as long. Epinotum subtruncate, with vertical or feebly concave declivity. From above, thorax truncate anteriorly; mesonotum with distinct anteromedian and parapsidal lines. Legs rather small, slender. Petiole slightly broader than long, with rounded anterior angles, produced and distinct posterior angles, and very weakly concave sides; lacking the extremely sharp anterolateral margins of *minus*. Gaster slender, compressed, with distinct constrictions between segments. Apex of seventh gastric sternum with short median and two acute lateral teeth.

Punctures on head, and especially on thorax, abundant, coarse, distinct. Head and gaster apparently more shining than other parts of body although these are also shining in certain lights.

Hairs yellowish, dense, rather closely appressed on all parts of body except head, legs, ventral surfaces of body, and tip of gaster, where they are longer and more suberect to erect.

Light brown or yellowish brown, with darker head. Wings hairy, deeply and uniformly infuscated, bearing brown veins and stigma, stigma prominent.

The description is drawn from 17 specimens in the collection of the United States National Museum, all of which appear to belong to the same series, although 8 of this number bear the label "Texas, Belfrage," and the other 9 only the label "Texas." Two of the latter, however, have in addition handwritten label *"Labidus fuscipennis* Cr." One of the handwritten labels seems to be that of Belfrage. From the available information it appears that *Labidus fuscipennis* is a manuscript name assigned by Cresson to specimens collected by Belfrage.

Two specimens in the National Museum collection are presumably the males described and figured by Wheeler (see paragraph below).

Type locality.—Texas, G. W. Belfrage.

Wheeler (1908) received for study from the National Museum two specimens under the manuscript name *"Acamatus fuscipennis* Cresson." After checking the specimens with Forel's description of *spoliator,* Wheeler stated that they "agree so closely with the above description that I do not hesitate to assign them to Forel's species." Forel described *spoliator* from a specimen taken in Costa Rica by Alfaro (Forel, 1899-1900).

I have not been fortunate enough to see the type of *spoliator,* but I have had an opportunity to examine two specimens collected at light at San Jose, Costa Rica, by C. F. Nevermann, one on June 10, 1938, and the other on June 20, 1937. Both specimens agree more closely with Forel's description of *spoliator* than the Texas specimens. Belfrage's specimens differ from those of Nevermann in their larger size; larger mandible with broader and more flattened base; larger eyes and ocelli; more feebly developed ridge above antennal socket; less strongly protuberant posterior corner of head; darker wings; and more abundant but finer punctures of the thorax. The paramere is also less truncate apically and more rounded on its ventral border. These differences, in my opinion, warrant considering Belfrage's specimens a distinct species, namely *fuscipennis,* for which name Wheeler should be credited as the author.

The male of *fuscipennis* can be distinguished by its rather small size; slender form; long, curved, very acutely tapering mandible; strongly projecting posterior corner of the head; subfiliform antennal funiculus; faintly toothed tarsal claws; deeply infuscated wings; and yellowish-brown body with blackish head.

This species might be confused with *melsheimeri,* to which it bears a resemblance in size, form, protuberant posterior corners of the head, and the shape of the mandibles. It can be very easily distinguished from *melsheimeri,* however, by its larger size, longer mandibles, deeply infuscated wings, and much shorter pilosity.

ECITON (NEIVAMYRMEX) OSLARI Wheeler

Eciton (Acamatus) oslari Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 415, pl. 26, fig. 8, ♂; Emery, 1910, Gen. Insect., Fasc. **102**:27.

Male.—Length 10-11 mm. (Pl. 5, Fig. 18).

Head approximately one and seven-tenths times as broad as long. Eye very large, convex, protuberant. Ocelli large, placed on protuberance well elevated above general surface of head, summit of protuberance concave; lateral ocellus less than its greatest diameter from inner margin of eye. Frontal carinae well developed, rather sharply edged, with a distinct groove between them extending to anterior ocellus. Antennal scape not much wider than base of funiculus, approximately as long as combined length of first 3 funicular segments; funiculus very long, subfiliform, of almost same width throughout; all segments except first distinctly longer than broad. A rather pronounced ridge above each antennal socket. Posterior corner of head not angularly protuberant between lateral ocellus and inner border of eye. Mandible moderately long, sickle shaped, more or less gradually curved and tapering toward the pointed apex. Head, from above, distinctly projecting behind eyes. Eye, in profile, large but not occupying all of side of head, there being a rather large area posterodorsad. Region of head back of ocelli, in profile, flattened or slightly convex; occipital flange lacking. Thorax slender. Prothorax. in profile, with strong, transverse impression; slightly projecting above head. Mesonotum with anteromedian and parapsidal lines. Epinotum, in profile, concave or subtruncate, its base approximately one-half length of declivity. Legs small, especially anterior pair; metatarsus of middle leg approximately one-half length of tibia; tarsal claws usually toothed, but weakly so. Petiole one and two-thirds times as broad as long. Gaster slender. Base of seventh gastric sternum with a thick, blunt, somewhat emarginate, transverse ridge; apex of sternum with 3 teeth, the 2 lateral teeth acute, the intermediate tooth short and blunt, most clearly seen in profile. Paramere, in profile, strongly bifurcate at apex, the upper branch forming an elongated, curved, fingerlike process, and the lower branch a structure that resembles the mold board of a plow.

All parts of body and appendages shining in some lights except funiculi. Dorsal surface of head especially shining. Head and mandibles with small, scattered punctures; thorax covered with numerous but rather fine punctures, those on side of thorax and posterior part of mesonotum largest, most distinct.

Hairs yellowish gray, short, appressed; rather dense on all parts of body; longer and more suberect on head, legs, mesopleura, and venter. Seventh gastric sternum with an unusually dense and rather long group of hairs.

Reddish brown, with upper surfaces of head and thorax usually darker. On some specimens mesonotum with 3 dark, longitudinal fasciae. Wings grayish, with brownish-black veins and stigma.

Described from a specimen belonging to the Museum of Comparative Zoology and erroneously labeled cotype and from 6 specimens from the localities listed below.

Holotype in American Museum of Natural History.

Type locality.—Nogales, Arizona, July 15, 1908, E. J. Oslar.

Material studied.—ARIZONA: Catalina Mountains, 5,500 feet, 1917; Rincon Moun-

tains, 7,500 feet, A. A. Nichol; Fort Grant, Hubbard; Globe, 8-8-35, H. Parker; Nogale, 7-9-03, E. J. Oslar.

The male of *oslari* is distinguished from those of other species by its slender form; by the shape of antennae and mandibles; by its large eyes and ocelli; its small legs; the transverse ridge at the base of the seventh gastric sternum; the color of the body and wings, and the nature of the pilosity.

The specimens studied showed very little variation. However, the head and thorax of some individuals are darker than those of others. The abundance and size of the punctures on the head vary as well as the distance between the inner border of the eye and the lateral ocellus. In no instance is the space between the eye and the lateral ocellus greater than the greatest diameter of the lateral ocellus. Wheeler's description states that the subgenital plate (seventh gastric sternum) of the male is bifurcated, but this was not found to be true of the specimen examined by me. It is possible that he overlooked the small, median tooth, which is clearly seen only in profile.

The range of *oslari* is no doubt greater than that indicated by the records above. Males have been collected during July and August.

ECITON (NEIVAMYRMEX) ARIZONENSE Wheeler

Eciton (Acamatus) arizonense Wheeler, 1908, Bull. Amer. Mus. Nat. Hist. **24**: 414 pl. 26, fig. 5, ♂.

Eciton (Acamatus) arizonensis Wheeler, Emery, 1910, Gen. Insect., Fasc. **102**: 25.

Male.—Length 12-13 mm. (Pl. 5, Fig. 19).

Head approximately twice as broad as long. Eye large, strongly convex, protuberant. Ocelli large, placed on high protuberance above general surface of head; from above, appearing as if on a distinctly elevated, transverse ridge; lateral ocellus less than its greatest diameter from inner margin of eye. Frontal carinae elevated, sharply margined, slightly converging posteriorly, with deep groove between them. Antenna short; scape robust, very noticeably wider than base of funiculus, but slightly shorter than combined length of first 4 funicular segments; funiculus distinctly tapering from base to apex. Clypeus excised. Mandible flattened dorsoventrally, very long, strongly curved, especially toward apex, and tapering to form an extremely acute point. Head, from above, remarkably broad and short, not prolonged behind eyes. Thorax very robust, strongly protruding above dorsal surface of head. Mesonotum with distinct anteromedian and parapsidal lines. Epinotum, in profile, concave. Tarsal claws toothed. Petiole with a protuberance beneath. Apex of seventh gastric sternum with 3 teeth; a short, somewhat blunt, median tooth, and 2 rather acute lateral teeth. Paramere, in profile, abruptly enlarged toward apex, and with a dorsal emargination which varies considerably with regard to depth and breadth.

Head and anterior border of each gastric segment smooth and shining; remainder of body more opaque. In some lights, various parts of the body have a glabrous appearance in spite of the dense hairs covering the surface. Thorax, petiole, and gaster very finely punctulate.

Hairs yellowish, rather dense and somewhat appressed; usually longer on lower surface of body, epinotum, petiole, and tip of gaster.

Yellowish brown to reddish brown, with darker head and seventh gastric sternum. Wings distinctly yellowish, pilose, with light-brown or yellowish-brown veins and stigma.

The description is drawn from a cotype male in the Museum of Comparative Zoology bearing the label Nogales, Ariz., 8-5-03, E. J. Oslar, and from males from the various localities mentioned below.

Male cotypes in Museum of Comparative Zoology.

Type locality.—Nogales, Ariz.; E. J. Oslar.

Material studied.—ARIZONA: Tucson, 7-10-30, 7-5-34, E. D. Ball; Fort Grant, Pinaleno Mountains, 7-5-17, 7-17-17, in Cornell University collection; Highley, 7-?-17; Nogales, 7-9-03, 7-15-13, 8-5-03, 6-21-03, 6-23-03, E. J. Oslar. NEW MEXICO: Deming, 7-12-17, W. M. Wheeler; Mesilla Park, 7-12-17; Pyramid Peak, Dona Anna County, 7-21-30, F. R. Fosberg. TEXAS: Cypress Mills, in W. H. Ashmead and F. H. Chittenden collections; Brownsville, 6-?-04, H. S. Barber; Brownsville, 5-?-?, 6-?-?, in Brooklyn Museum collection; Helotes, 7-1-17, in Cornell University collection; Weslaco, 6-2-30, S. W. Clark; Hidalgo County, 6-5-30, J. C. Gaines; New Braunfels, 6-26-17, in Cornell University collection; Fort Davis, 7-7-35, W. L. Owen, Jr.; Bastrop County, 7-20-37; Dimmitt County, 6-24-34, S. E. Jones; Victoria, 8-28-03, 7-29-03, A. W. Morrill; Travis County, 6-27-02, M. Holliday.

MEXICO: La Buena Vista, Sierra de la Encontada, 5,000 feet, 7-7-38, R. H. Baker; Tlahualilo, 7-?-05, A. W. Morrill.

COSTA RICA: 5-5-38, C. F. Nevermann.

Wheeler (1908) records the species from Brownsville and Austin, Tex.; Las Cruces, N. Mex.; and Nogales, Ariz.

The male of *arizonense* is distinguished by the form of the mandibles; its short antenna with strongly tapering funiculus; large eyes and ocelli; stout thorax which projects forward prominently above the head; concave epinotum; toothed claws; the nature of the pilosity; and the coloring of the body.

Variation was noted in size, length of antenna, length of body hairs, width of space between eye and lateral ocellus, convexity of eye, acuteness of teeth on seventh gastric sternum, shape of emargination on dorsal border of paramere, and opaqueness of body.

The male should not be confused with that of any other species of *Neivamyrmex* in the United States. Superficially, it strongly resembles in size and color the male of *pilosum* but can be immediately distinguished from it by the shape of the mandibles, the lack of a distinct median groove on the epinotum where the base and declivity meet, and the lack of an occipital flange on the posterior part of the head. The male of *pilosum* also has the thorax more protruding anteriorly; darker head, legs, and seventh gastric sternum; and it usually has shorter pilosity.

This species seems to be confined in the United States to the extreme Southwest but extends southward at least as far as Costa Rica. Specimens have been collected from May through August but most commonly during June and July.

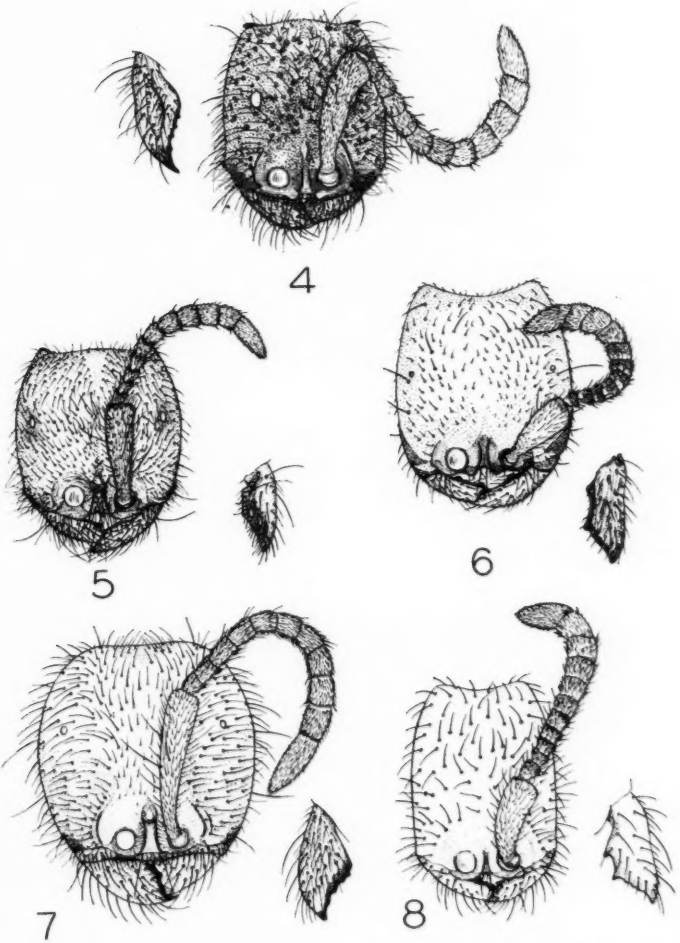


PLATE 1.—Head and mandible of major worker of (4) *Eciton (Neivamyrmex) nigrescens* (Cresson); (5) *wheeleri* Emery; (6) *commutatum* Emery; (7) *pilosum* F. Smith; (8) *pauxillum* Wheeler.

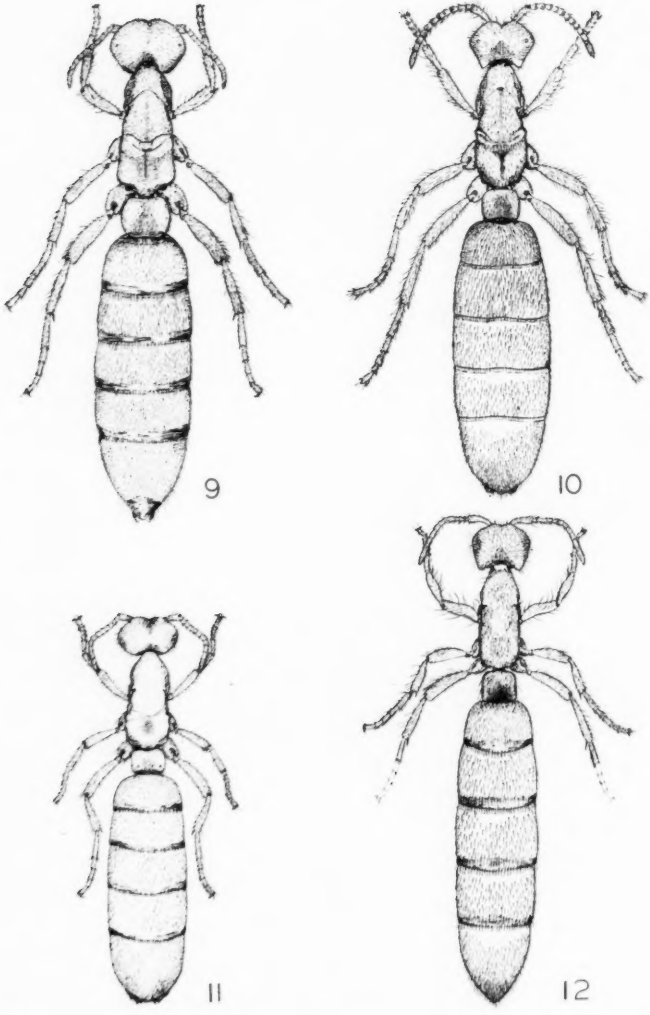
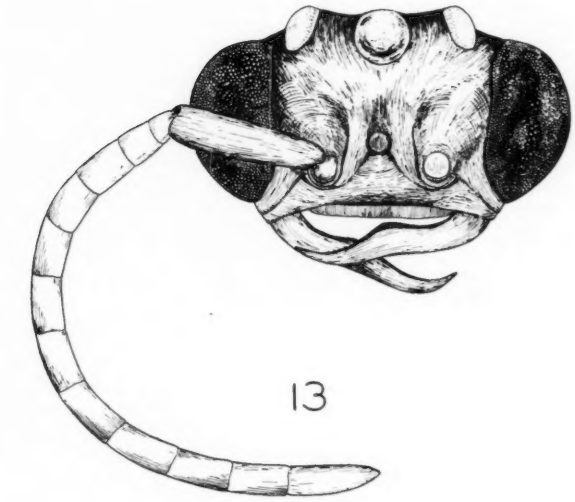


PLATE 2.—Female of (9) *Eciton (Neivamyrmex) opacithorax* Emery; (10) *nigrescens* (Cresson); (11) *carolinense* Emery; (12) *wheeleri* Emery.



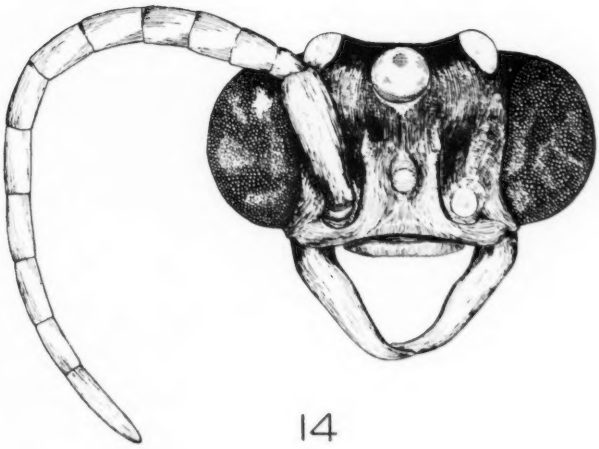


PLATE 3.—Head of the male of (13) *Eciton (Neivamyrmex) pilosum* F. Smith; (14) *pilosum mandibulare*, new subspecies.

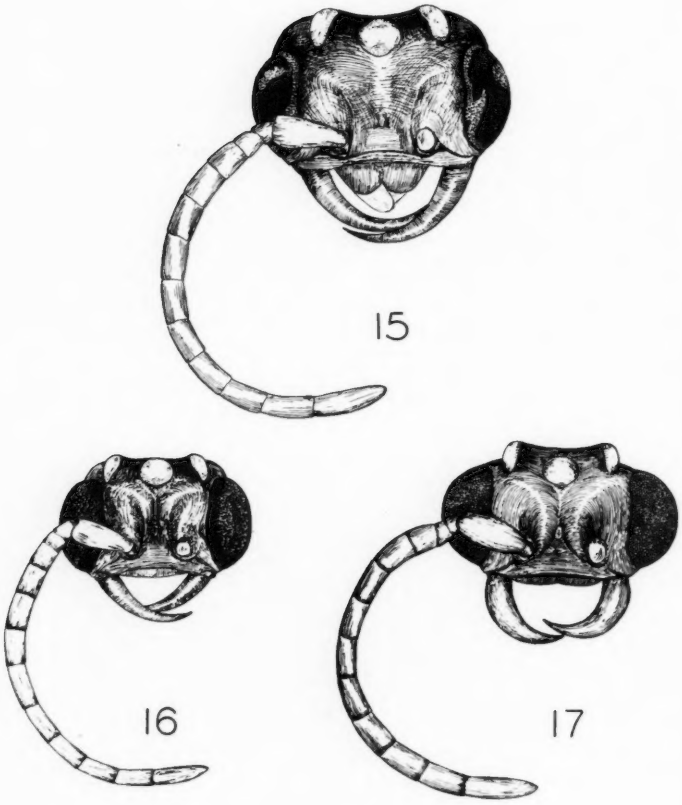


PLATE 4.—Head of the male of (15) *Eciton (Neivamyrmex) fuscipennis* Wheeler; (16) *melsheimeri* (Haldeman); (17) *minus* (Cresson).

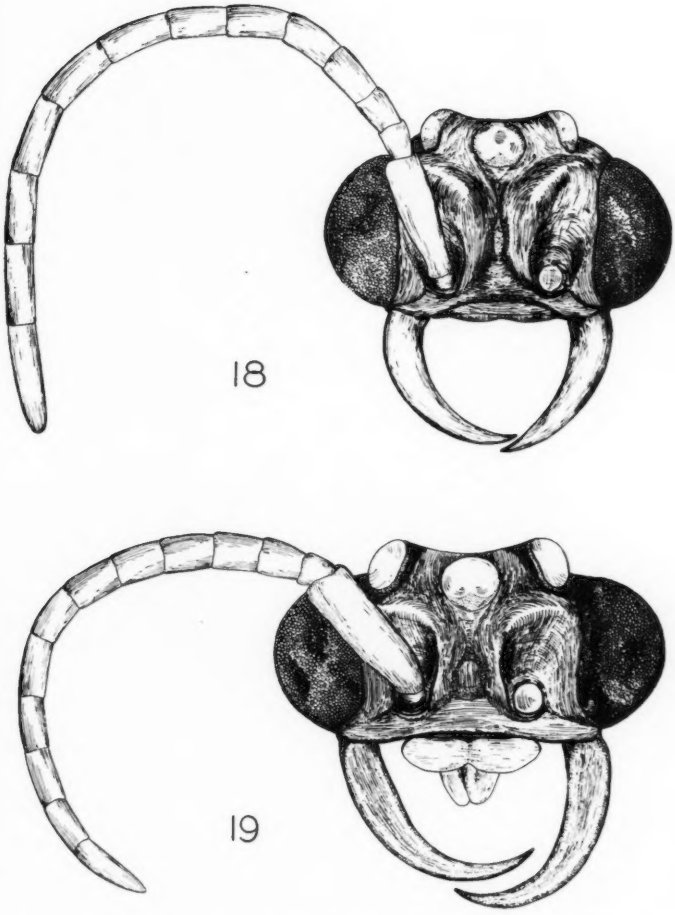
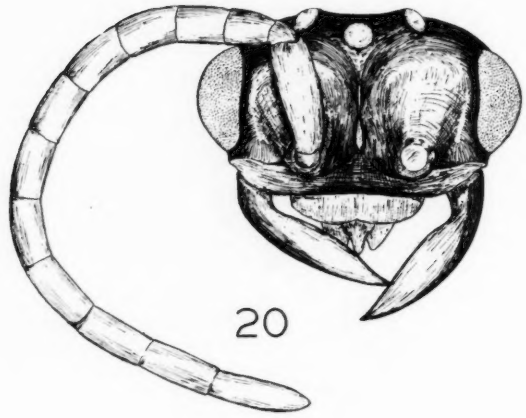


PLATE 5.—Head of the male of (18) *Eciton (Neivamyrmex) oslari* Wheeler; (19) *arizonense* Wheeler.



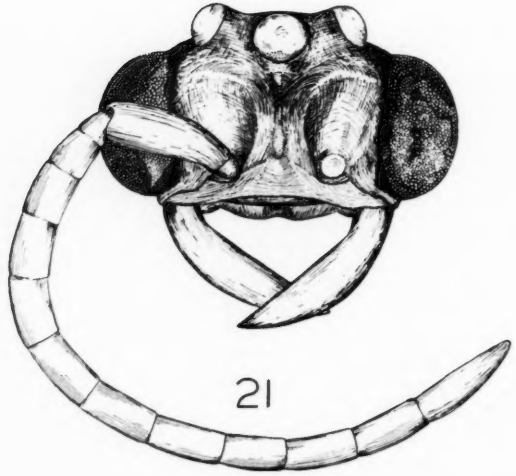


Plate 6.—Head of the male of (20) *Eciton (Neivamyrmex) opacithorax* Emery; (21) *harrisii* (Haldeman).

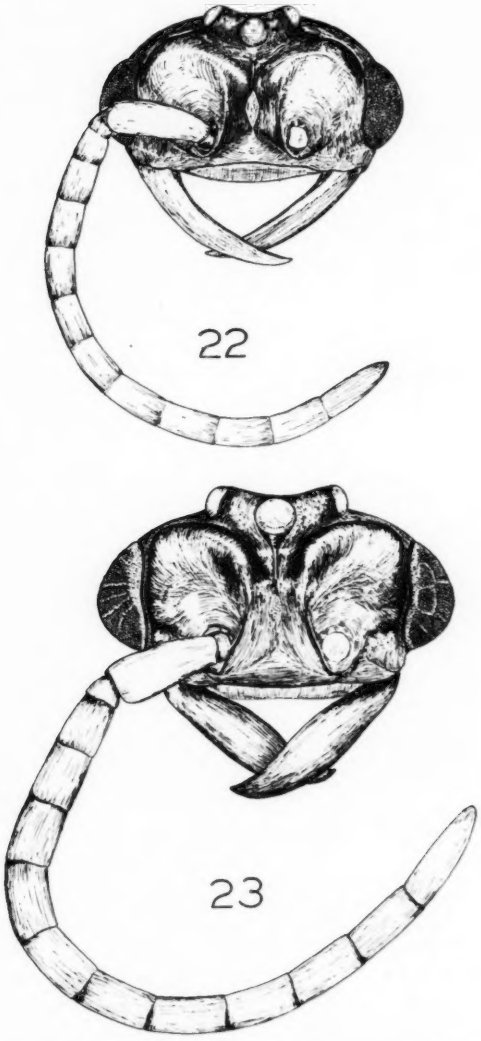


PLATE 7.—Head of the male of (22) *Eciton (Neivamyrmex) carolinense* Emery; (23) *nigrescens* (Cresson).

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INDEX TO SPECIES

BUREAU OF ENTOMOLOGY
AND PLANT QUARANTINE,
U. S. DEPT. OF AGRICULTURE,
WASHINGTON, D. C.

Contributions to a Synopsis of the Hemiptera of Missouri, Pt. II.*

Coreidae, Aradidae, Neididae

Richard C. Froeschner

This is a continuation of the author's attempt to fill part of the gaps that exist in the systematic study of Missouri entomology. Here, as in Part I, the treatment is probably incomplete not only as to the local geographic and seasonal distribution but also as to the included species. However, the great need for some sort of a practical treatment of these groups in Missouri prompts the publication hereof.

My own collection formed the nucleus for this work. Additional data from other sources are included. Grateful acknowledgment is made to Dr. E. P. Meiners, W. S. Craig, W. R. Enns, Dr. L. Haseman of the University of Missouri, and J. A. Denning, the State Entomologist, all of whom granted access to collections of their own or those in their charge. I also sincerely appreciate the cooperation of the following men who, at my request, sent Missouri records from collections in their charge: H. G. Barber of the National Museum, H. B. Hungerford at the University of Kansas, and H. H. Knight for records in his personal cabinet.

Dr. H. M. Harris of Ames, Iowa, very kindly checked a large number of my specimens of the genus *Corizus* and made some useful suggestions.

Records not my own are initialed to indicate the person responsible for them, as in the following list:

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For the fine plates, all figures of which are original, I owe thanks to my wife, Elsie Herbold Froeschner.

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KEYS TO THE MISSOURI SUBFAMILIES, TRIBES, GENERA AND SPECIES OF COREIDAE

1. Osteole usually with a distinct raised auricle (except in *Tollius* and *Stachyocnemus* where the width of the head between the eyes is greater than the width of the base of scutellum); coria opaque; color never black and red 2

Osteole without a raised auricle (width of head between eyes less than that of base of scutellum); coria usually hyaline, when opaque then color black and red.....Subfamily *Corizinae*.....18

2.(1). Head narrower, width between eyes less than that of base of scutellum; form stout, (Figs. 37-45) 3

Head wider, width between eyes greater than that of base of scutellum; form slender, (Figs. 46 and 48).....Subfamily *Alydinae*.....14

3.(2) Apex of hind tibiae ending beneath in a spine; hind femora strongly clavate, spined beneath, (Fig. 37); antennal IV equal to or longer than II and III together.....Subfamily *Merocorinae*.....I. *Merocoris*

Apex of hind tibiae not ending beneath in a spine; hind femora rarely clavate; antennal IV much shorter than II and III together 4

4.(3). Upper surface without small bristle-bearing granules; hind coxae widely separated; veins of membrane arising directly from apical margin of corium.....Subfamily *Coreinae*..... 5

Upper surface, except membrane, thickly beset with bristle-bearing granules; hind coxae contiguous or nearly so; veins of membranes arising from a transverse vein remote from the apical margin of corium..... Subfamily *Pseudophloeinae* 13

5.(4). Hind tibiae with leaf-like dilations on both sides 6
Hind tibiae simple, without leaf-like dilations 7

6.(5). Antennal I at least one-half longer than head; tylus longer than jugae, compressed between them so as to form an upward projecting plate .....Tribe *Acanthocephalini*.....II. *Acanthocephala*

Antennal I but little if any longer than head; tylus longer than jugae, compressed and either prolonged anteriorly as a spine or deflexed .....Tribe *Anisoscelini*.....III. *Leptoglossus*

7.(5). Hind femora swollen, tuberculate above; antennal tubercles separated by a space less than the width of one of them; antennae simple Tribe *Mictini* 8
Hind femora not swollen and not tuberculate above; antennal tubercles usually separated by a space greater than the width of one of them, when not so separated antennal III is dilated on both sides 10

8.(7). Truncate hind margin of pronotum not wider than base of scutellum..... .....IV. *Mozena*

Truncate hind margin of pronotum much wider than base of scutellum..... 9

9.(8). Antennal tubercles not spinose .....V. *Archimerus*
Antennal tubercles with a distinct spine on outer front angles....VI. *Euthochtha*

10.(7). Antennal III dilated on each side at apical third; humeri produced as acute spines.....Tribe *Chariesterini*.....VII. *Chariesterus*
Antennal III not dilated; humeri not spinose 11

11.(10). Antennae with first three segments triquetrous, or three-sided; head three-fourths or more of the length of the pronotum, narrowed and produced in front of the bases of the antennae....Tribe *Chelinidini*....VIII. *Chelinidea*
Antennae cylindrical throughout; head not over two-thirds of the length of the pronotum.....Tribe *Coreini*.....12

12.(11). Osteolar auricle without a tubercle anteriorly; antennal insertion guarded beneath by a small plate-like expansion of the gena; outer anterior angle of antennal tubercle (in our species) with prominent stout spine .....IX. *Catorhintha*

Osteolar auricle with a tubercle anteriorly; antennal insertion without the plate-like expansion beneath; outer apical angle of antennal tubercles without a spine.....X. *Anasa*

13.(4). Beak not reaching middle coxae; humeral angles of pronotum rounded and unarmed .....XI. *Ceraleptus*
Beak reaching between middle coxae; humeral angles with a fuscous tooth .....XII. *Coriomeris*

14.(2). Hind femora unarmed beneath; jugae longer than tylus and contiguous in front of it.....Tribe *Micrelytrini*.....XIII. *Protenor*
Hind femora armed beneath with one or more rows of spines; jugae shorter than tylus.....Tribe *Alydini*.....15

15.(14). Antennal I distinctly passing apex of head; osteolar auricles present and distinct 16
Antennal I not passing apex of head; osteolar auricle absent.....17

16.(15). Antennal I longer than II .....XIV. *Megalotomus*
Antennal I shorter than II .....XV. *Alydus*

17.(15). Hind tibiae unarmed .....XVI. *Tollius*
Hind tibiae armed beneath with two rows of spines .....XVII. *Stachyocnemus*

18.(1). Hind femora spined beneath; apical angles of pronotum produced forward into acute spines.....Tribe *Harmostini*.....19
Hind femora unarmed; anterior angles of pronotum obtuse or rounded.....20

19.(18). Abdomen not dilated at middle, connexivum not exposed; pronotum without a longitudinal median impression .....XVIII. *Harmostes*
Abdomen dilated at middle, connexivum widely exposed; pronotum with a longitudinal median impression with raised ridges along either side.....XIX. *Aufeius*

20.(18). Coria hyaline; length less than 8 mm; lateral margins of pronotum entire .....Tribe *Corizini*.....XX. *Corizus*
Coria opaque; length more than 10 mm; lateral margins of pronotum notched just behind front angles.....Tribe *Leptocorini*.....21

21.(20). Bucculae less than half the length of the head; beak rarely passing hind coxae .....XXI. *Leptocoris*
Bucculae as long as head; beak reaching to or beyond second abdominal segment .....XXII. *Jadera*

I. *Merocoris* Perty

1. Beak not surpassing middle coxae; head not prolonged anteriorly; length 7.5-8.5 mm. .....80. *distinctus* Dall. (Fig. 37)

II. *Acanthocephala* Laporte

1. Apical antennal segment not distinctly paler than the other three; outer dilation of hind tibiae extending almost or quite to apex 2
Apical antennal segment bright orange or pale green in distinct contrast to the color of the other three; outer dilation of hind tibiae reaching but three-fourths of the way to the apex; length 20-25 mm. .....81. *terminalis* (Dall.) (Fig. 39)

2.(1). Humeral angles expanded and elevated; disk of pronotum not coarsely granulate; length 28-34 mm. .....82. *declivis* (Say)
Humeral angles not expanded and elevated; disk of pronotum with numerous distinct coarse granules; length 25-28 mm. .....83. *femorata* (Fab.) (Fig. 38)

III. *Leptoglossus* Guerin

1. Tylus prolonged forward as an acute spine; coria with a transverse zigzag bar across their middles; length 16-20 mm. .....84. *clypealis* Heid. (Fig. 42)

Tylus not so prolonged 2

2.(1). Antennal IV equal to or shorter than III; outer dilation of hind tibiae not scalloped; length 16-19 mm. .....85. *corculus* (Say)

Antennal IV distinctly longer than III; outer dilation of hind tibiae scalloped 3

3.(2). Pronotum with a curved yellow interhumeral line; humeri with long distinct spines; length 16-18 mm. .....86. *gonagra* (Fab.)

Pronotum without interhumeral pale line; humeri not spinose 4

4.(3). Coria with a very small, oblique white spot on nervure opposite base of membrane; side margins of pronotum behind the humeri entire; length 17-20 mm. .....87. *oppositus* (Say)

Coria with a transverse straight white bar across them at the bases of the membranes; side margins of pronotum behind the humeri crenulate or toothed; length 17-21 mm. .....88. *phyllopus* (Linn.)

IV. *Mozena* Amyot & Serville

1. Reddish-brown with incisures of widely exposed connexivum paler; humeri prominent, tips subacute; length 20-22 mm. .....89. *obesa* Mont.

V. *Archimerus* Burmeister

1. Antennae less than half as long as body; connexivals alternately fuscous and yellow; length 16-21 mm. .....90. *alternatus* (Say)

VI. *Euthochtha* Mayr

1. Basal antennal segment twice as long as head; pronotum with front angles produced as a short tooth; length 15-17 mm.....91. *galeator* (Fab.) (Fig. 41)

VII. *Chariesterus* Laporte

1. Sides of pronotum tuberculate in front of humeri; postocular spines simple or tuberculate; length 11-14 mm. .....92. *antennator* (Fab.) (Fig. 40)

VIII. *Chelinidea* Uhler

1. Pronotum with humeri rounded, side margins entire; connexivum widely exposed; membrane not reaching apex of abdomen; length 13-15 mm. .....93. *vittiger* Uhl. (Fig. 44)

IX. *Catorhintha* Stal

1. Venter with a series of larger black dots on either side; length 8-9 mm. .....94. *guttula* (Fab.)

Venter with all black spots subequal in size; length 10-12 mm. ....95. *mendica* Stal

X. *Anasa* Amyot & Serville

1. Head fuscous with a median yellow stripe; length 13-18 mm. ....95. *tristis* (DeG.) (Fig. 45)

Head without a median yellow stripe 2

2.(1). Head armed on each side at base of antennae with a spine which is about one-third of the length of the first antennal; length 13-17 mm. ....97. *armigera* (Say)

Head without spines at bases of antennae; length 14-16 mm....98. *repetita* Heid.

XI. *Ceraleptus* Costa

1. Grayish-yellow with numerous fuscous punctures; head with median and supraocular lines yellow, its apex passing middle of antennal I; antennal tubercles spined on outer angle; length 10-13 mm. ....99. *americanus* Stal (Fig. 43)

XII. *Coriomerus* Westwood

1. Dull grayish-white, densely punctured; membrane gray, veins brown; connexivum alternately fuscous and yellow; length 8.5-9 mm. ..... 100. *humilis* Uhl.

XIII. *Protenor* Haglund

1. Head less than one-fourth longer than pronotum; upper and lower apical processes of jugae contiguous or nearly so throughout their length; length 12-15 mm. ..... 101. *belfragei* Hagl.

XIV. *Megalotomus* Fieber

1. Color dull reddish-brown, basal third of antennal IV pale; humeri prominent, acute; length 14-16 mm. ..... 102. *quinquespinosus* (Say) (Fig. 48)

XV. *Alydus* Fabricius

1. Pronotum with humeri obtuse and lateral margins and sides not paler than disk 2

   Pronotum with humeri acute and lateral margins and sides paler than disk; length 10-14 mm. ..... 105. *pilosulus* (H-S)

2.(1). Pronotum with disk entirely black; head and pronotum with numerous erect hairs; length 11-15 mm. ..... 103. *eurinus* (Say) (Fig. 46)

   Pronotum with posterior half or more colored in strong contrast to the black apical portion; head and pronotum with few or no hairs; length 10-12 mm. ..... 104. *conspersus* Mont.

XVI. *Tollius* Stal

1. Elongate-oblong; above dull yellow spotted with fuscous; membrane pale with fuscous mottlings; connexivum covered; length 9.5-12 mm. ..... 106. *curtulus* (Stal)

XVII. *Stachyocnemus* Stal

1. Pronotum with hind margin sinuate and with a small median tooth; hind femora swollen and with two rows of spines beneath; length 7.5-8 mm. ..... 107. *apicalis* (Dall.)

XVIII. *Harmostes* Burmeister

1. Antennal I but slightly surpassing apex of head; costal margin of hemelytra spotted with fuscous; length 6-8 mm. ..... 108. *fraterculus* (Say)

   Antennal I surpassing apex of head by at least one half its length; costal margin of hemelytra unicolorous; length 7.5-9 mm. ..... 109. *reflexulus* (Say) (Fig. 49)

XIX. *Aufeius* Stal

1. Hemelytra in great part membranous, hyaline, veins coriaceous; black dot behind each front coxa; length 5-6 mm. ..... 110. *impressicollis* Stal

XX. *Corizus* Fallen

1. Pronotum not punctate along front margin; apical abdominal segment short and broad; length 5.5-6.5 mm. ..... 111. *hyalinus* (Fab.)

   Pronotum distinctly punctate along front margin 2

2.(1). Width of head across eyes subequal to length of pronotum along median line; dorsum of abdomen with a broad black cross-band which covers segments III, IV and V; length 4.4-8 mm. ..... 112. *sidae* (Fab.)

   Width of head across eyes one-third greater than length of pronotum along median line; dorsum of abdomen not marked as above 3

3.(2). Antennal I not attaining apex of tylus; beak surpassing hind coxae (in

our specimens), its first segment reaching base of head; length 5-6 mm. .....113. *bohemanii* Sign.

Antennal I surpassing apex of tylus; beak scarcely or not attaining hind coxae, its first segment not reaching base of head; length 4.5-7 mm. .....114. *lateralis* (Say) (Fig. 51)

XXI. *Leptocoris* Hahn

1. Above black with the following parts red: ocelli, median line and lateral and basal margins of pronotum, tip of scutellum and all margins and nervures of corium; length 11-13.5 mm. .....115. *trivittatus* (Say) (Fig. 47)

XXII. *Jadera* Stal

1. Color black with the following parts red: eyes and their orbits, bucculae, margins of abdomen, sixth ventral and genitalia; length 10-14 mm. ....116. *haematoloma* (H-S)

KEYS TO THE MISSOURI SUBFAMILIES, GENERA AND SPECIES OF ARADIDAE

1. Head not wider behind the eyes than just in front of them; prosternum with a median longitudinal groove .....Subfamily *Aradinae*.....I. *Aradus*
Head distinctly wider behind eyes than just in front of them; prosternum without a median groove .....Subfamily *Mezirinae*..... 2

2.(1). Ventrals III, IV and V with a longitudinal carina between spiracles and lateral margins .....II. *Neuroctenus*
Ventrals without carina between spiracles and lateral margins; membrane with veins .....III. *Mezira*

I. *Aradus* Fabricius

1. Beak extending beyond base of head 2
Beak not reaching beyond base of head; antennae thicker than front femora; length 5-6.5 mm. .....129. *niger* Stal

2.(1). Pronotum with longitudinal median carinae distinct and extending to anterior margin 3
Pronotum with longitudinal median carinae but slightly developed, obsolete anteriorly; color reddish-brown; antennae but slightly longer than head; length 3-5 mm. .....126. *cinnamomeus* Panz.

3.(2). Antennal II but slightly longer than III. 4
Antennal II distinctly longer than III 5

4.(3). Lateral margins of abdomen almost entire; pronotum widest slightly behind middle; length 8.2-10 mm. .....117. *aequalis* Say
Lateral margins of abdomen strongly crenate; pronotum widest well before the middle; length 8-11 mm. .....118. *crenatus* Say

5.(3). Antennal III swollen, about one-and-one-half times as thick as II; length 7.5-9 mm. .....119. *quadrilineatus* Say
Antennal III not or only slightly thicker than II. 6

6.(5). Antennae thicker than front femora 7
Antennae not thicker than front femora 8

7.(6). Scutellum subpentagonal, its sides slightly elevated behind middle; antennae unicolorous; length 5.5-7 mm. .....120. *robustus* Say
Scutellum triangular, its sides strongly elevated behind middle; antennal I distinctly paler than others; length 6-6.7 mm. .....121. *duzeei* Berg.

8.(6). Side margins of pronotum with distinct denticles or teeth 9
Side margins of pronotum without denticles or teeth, at most granulate.....12

9.(8). Antennal II cylindrical from base to near apex where it is slightly enlarged, III with apical two-thirds pale; pronotal disk strongly elevated before and behind the transverse impression, inner lateral carinae ending

anteriorly in a blunt tubercle; length 5.8-6.6 mm. ..... 122. *cincticornis* Berg. (Fig. 55)

Antennal II gradually enlarged from near base to apex or cylindrical with apical third strongly and suddenly enlarged; pronotal disk and carinae not as above 10

10.(9). Length of antennal II subequal to distance between the eyes; length 4.5-8.4 mm. ..... 123. *similis* Say

Length of antennal II at least as long as width of head including one eye 11

11.(10). Antennal II less than three times as long as III; a row of subquadrate pale spots either side of exposed disk of abdomen; length 7-9.5 mm. ..... 124. *acutus* Say (Fig. 54)

Antennal II more than three times as long as III and gradually enlarged from near base; sides of pronotum with numerous irregular teeth; abdomen reddish above and beneath; length 8.5-10 mm. ..... 125. *inornatus* Uhl. (Fig. 53)

12.(8). Antennal III two-thirds as long as II; length 3.7-5 mm..... 130. *falleni* Stal

Antennal III less than half as long as II 13

13.(12). Antennal II strongly constricted at basal third; length 4.8-6.4 mm. ..... 128. *lugubris* Fall.

Antennal II not constricted at basal third; length 4.6-5.5 mm. 127. *abbas* Berg.

II. *Neuroctenus* Mayr

1. Jugae contiguous in front of the tylus; scutellum without a carina on apical half; length 4.5-6 mm. ..... 131. *simplex* Uhl. (Fig. 52)

III. *Mezira* Amyot & Serville

1. Lateral margins of pronotum sinuate; median carina of scutellum obsolete or very faint; length 4.8-5.5 mm. ..... 132. *granulata* (Say)

Lateral margins of pronotum acutely emarginate; median carina of scutellum distinct; length 7.5-8.5 mm. ..... 133. *lobata* (Say)

KEY TO MISSOURI SUBFAMILIES, GENERA AND SPECIES OF NEIDIDAE

1. Head short, without a decurved spine between bases of antennae ..... Subfamily *Metacanthinae* 2

Head elongate, with a forward-projecting, decurved spine between the bases of the antennae ..... Subfamily *Neidinae* ..... III. *Neides*

2.(1). Antennal IV longer than head; osteolar process straight, the canal on same side all the way to the apex ..... I. *Jalysus*

Antennal IV not longer than the head; osteolar process curved and twisted so that the canal lies on its outer face basally and on its upper face apically ..... II. *Aknisus*

I. *Jalysus* Stal

1. Head with a distinct, erect, blunt tubercle between bases of antennae (Fig. 50a.); pronotum with median and lateral carinae prominent, the latter reaching nearly or quite to humeral angles; length 6-7.1 mm. ..... 134. *wickhami* Van D. (Fig. 50)

Head not tuberculate between bases of antennae; pronotal carinae obsolete, the lateral ones rarely approaching humeral angles; length 6.1-7.4 mm. ..... 135. *spinosus* (Say)

II. *Aknisus* McAtee

1. Head with a prominent spinose tubercle between bases of antennae;

coria hyaline, without a dark spot at outer apical angle; length 5-6 mm. .....136. *multispinus* (Ashm.)

III. *Neides* Latreille

1. Antennals I and III subequal in length; pronotum densely and coarsely punctate, the carinae each ending posteriorly in a small tubercle; length 8.2-9.5 mm. .....137. *muticus* (Say)

Annotated List of Species

COREIDAE

80. *Merocoris distinctus* Dall. An uncommon species that should occur throughout the state. Specimens have been taken from *Ambrosia trifida* and *Cassia* and have been swept from fields in which neither of these plants were present. Uhler (1876) lists this species for the state under the genus *Corynocoris*. In his "Catalogue" VanDuzee (1917) records it for Missouri as a variety of *M. typhaeus* (Fab.). Adults have been collected from April 29 until November 3. Boone, Callaway (WRE), Crawford, Jefferson (EPM), Lafayette, McDonald, Pike (WSC), Schuyler (EHF) and St. Louis counties.

81. *Acanthocephala terminalis* (Dall.). This common species is undoubtedly state-wide in its distribution. It is an alert and active flier that usually frequents open woods or woodland borders. I have observed adults feeding on the tender shoots of *Carya*. Nymphs have been collected from June 12 until October 8. Adult records are from April 14 to October 12. The very early spring records indicate that this species might hibernate as an imago. In 1876 Uhler recorded this species for "Missouri" under the generic name of *Metapodius*. It was correctly listed for the state by VanDuzee (1917) and Gibson and Holdridge (1918). Barry, Bates, Boone, Butler, Carter (EHF), Callaway (WRE), Crawford, Dunklin, Franklin (WRE), Greene (RER), Iron, Jackson, Jasper (CA), Jefferson (EPM), Lafayette, Miller, Mississippi, Newton (CA), Oregon (WKC), Osage, Pemiscot, Pettis (WRE), Phelps, Pike, Pulaski, Saline (EHF), Shannon (EHF), St. Louis, Stoddard, Taney (HHK) and Vernon counties.

82. *Acanthocephala declivis* (Say). Two Missouri specimens of this southern species are at hand. One was collected in St. Louis on August 26, 1938 (Lisle Jeffrey) and the other was found freshly smashed on a sidewalk in Columbia on November 17, 1941 (WRE).

83. *Acanthocephala femorata* (Fab.). Extreme southeastern Missouri seems to be the northern limit of range for this southern species. Lugger's record of it in Minnesota was made at a time when the proper usage of specific names in this genus was not well known and so is probably incorrect. Since he figures *terminalis* and because *terminalis* is the only member of the genus that has otherwise been recorded for the northern states, it is quite probable that he had that species and not *femorata*. Blatchley (1926) follows Lugger and uses the above mentioned figure to illustrate *femorata* and also quotes the same authority on its occurrence in Minnesota. Special efforts to determine its range in Missouri places it in the southeastern lowland section where

it is scarce near the bluff line but gets more common as one progresses southward. Adults are very active, flying readily and for long distances. Nymphs and imagoes were numerous from August 8 to October 8. They were observed on many kinds of plants but none were seen to feed. Dunklin, New Madrid, Pemiscot and Stoddard counties.

84. *Leptoglossus clypealis* Heid. A western species that has been observed sucking juices from the stems and ripe berries of the Aromatic Sumac, *Rhus aromatica*. Nymphs were taken from the same plants during June. Adult records range from April 30 to July 13. Barry, Buchanan (CMG) and St. Louis (EPM) counties.

85. *Leptoglossus corculus* (Say). Although no Missouri records or specimens are available for this species, we can safely assume its occurrence within the state as it has been listed for Kansas and Tennessee.

86. *Leptoglossus gonagra* (Fab.). A single specimen of this southern species was found feeding on the under side of a stem of wild cucumber, *Sicyos*. It was taken near Tyler (Pemiscot Co.) on October 7.

87. *Leptoglossus oppositus* (Say). A not uncommon species that should be found throughout the state. Adults have been observed feeding on pumpkin, watermelon and wild cucumber vines. On one occasion nymphs and adults were found on Jimson weed, *Datura*. Adults have been collected from June 12 until November 20. Nymphs have been found from August 31 to October 8. VanDuzee (1917) and Blatchley (1926) both correctly record this species for the state. Barry, Boone, Buchanan (CMG), Cape Girardeau (EHF), Cass, Dunklin, Jasper (CA), Montgomery, Oregon (WKC), Pemiscot, Pike (WSC), St. Louis, Taney (HHK) and Vernon (EHF) counties.

88. *Leptoglossus phyllopus* (Linn.). This scarce species is probably of state-wide distribution. Records for adults are from July 6 to October 7. It has been listed for the state by Uhler (1876), VanDuzee (1917) and Blatchley (1926). Barton, Buchanan, Lawrence (WWS), Pemiscot and Taney (HHK) counties.

89. *Mozena obesa* Mont. Since Mr. W. R. Enns first brought in a series that he had taken from *Schrankia uncinata*, this species has been found quite commonly and in all stages on that plant. Without doubt, this is the true host-plant. Adults have been taken during the period from June 10 until July 12, while nymphs have been observed from June 1 until July 6. Barry, Boone, Callaway (WRE), Camden, Dent, Henry (WRE), Iron, Miller (WRE), Morgan (WRE) and Phelps counties.

90. *Archimerus alternatus* (Say). This uncommon species which was originally described from "Missouri Territory" as *Coreus alternatus* should occur throughout the state, but a little more abundantly in the southeastern section. One nymph was found feeding on fresh hickory growth on a wooded hillside on September 7. Another nymph was collected on August 20. Adults have been taken during the season from April 30 to October 8. Barry, Boone,

Carter, Crawford, Dunklin, Greene (HHK), Howell, Macon, Mississippi (WSC), St. Louis and Wright (M. I. Somes in U. S. N. M.) counties.

91. *Euthochtha galeator* (Fab.). This species should occur throughout the state. It is found most commonly in low, moist weedy sections of woods, but has also been swept from weedy fields. Mating was observed in June. Adults have been collected throughout the year, hibernating under bark and among fallen leaves and other debris on the ground. Numerous eggs and freshly emerged nymphs were found on *Monarda* on June 8. Nymphal records all fall during June and early July. Boone, Buchanan (CMG), Camden, Carter, Cass, Cole, Dallas, Franklin (WRE), Iron, Jasper (CA), Lafayette, Lawrence (WWS), McDonald (EHF), Miller, Mississippi (WSC), Newton (CA), Osage, Pemiscot, Pettis (WRE), Phelps, Pike (WSC), Saline, Ste. Genevieve, St. Louis and Stone counties.

92. *Chariesterus antennator* (Fab.). This very common species probably will be found throughout the state. It is a strong flier that occurs in a variety of habitats but apparently prefers the drier places. Nymphs have been found from July 3 until October 14. Adults occur the year around, hibernating among fallen leaves and in grass clumps. Barry, Barton (RER), Boone, Buchanan, Caldwell (EHF), Callaway (WRE), Carter, Chariton, Crawford, Daviess, Franklin, Henry, Holt, Iron, Jackson, Jefferson, Lawrence (WWS), Lincoln, Madison, Mississippi, Morgan (EHF), Oregon, Osage (EHF), Pemiscot, Pike, Polk, Pulaski, St. Louis, Stoddard, Taney and Texas counties.

93. *Chelinidea vittiger* Uhl. Common on the pads and fruit of the local cactus, *Opuntia Rafinesquii*. Because this insect is so specific in its food requirements, its distribution in the state will undoubtedly be limited by the range of its host. Palmer and Steyermark in their "Catalogue of the Flowering Plants of Missouri" give the following as the range of this plant: "south of a line drawn from Ralls, Monroe, Boone and Saline counties." Adults have been found during every month of the year, hibernating beneath the cactus pads and under loose bark on nearby trees. Freshly hatched nymphs were seen clustered on a pad on May 29 and that stage was to be found from then until September 15. Benton (WRE), Boone, Iron, Ste. Genevieve, St. Louis, Taney and Texas (EHF) counties.

94. *Catorhintha guttula* (Fab.). This southern species, which has been found as far north and west as Kansas, should be looked for in Missouri.

95. *Catorhintha mendica* Stal. This uncommon species will probably be found throughout the state. On one occasion a dozen specimens were taken from the unopened flower-heads of *Helianthus anuus*. A single specimen was found under a dead snake. Adults have been collected from April 13 until October 19. Boone, Buchanan (CMG), Crawford (EHF), Pike (WSC), St. Louis, Saline and Taney (HHK) counties.

96. *Anasa tristis* (DeG.). This is the well-known and all too common "Squash bug" that occurs throughout the state. Adults are to be found the year around, hibernating under loose bark, stones, leaves and other protected

places. Eggs first appear in May and from then on until frost one can find both eggs and nymphs. The list of food plants for this species includes nearly all the cucurbits. Say's synonym, *Coreus ordinatus*, was described in part from Missouri. Barry, Bates, Boone, Buchanan, Carter, Cass, Crawford, Dade, Daviess, Henry, Howard, Jackson, Jefferson, Lawrence (WWS), Maries, Marion, Mercer, Montgomery, Pemiscot, Pike (WSC), Polk, Pulaski, Oregon, Osage, St. Louis, Saline, Schuyler, Vernon and Wayne counties.

97. *Anasa armigera* (Say). Originally described as *Coreus armigera* from "Missouri Territory" this species is very common in the southeastern lowlands where adults and nymphs were taken from *Sicyos*. Farther north it is only locally abundant. On one occasion innumerable adults and nymphs were found on watermelon vines in a patch near Columbia. They caused the same injury to these vines as *A. tristis* does to pumpkins. Nymphs have been taken from August 25 to October 7. Adult records are from May 12 to October 7. Blatchley (1926) cites Say's "Missouri Territory" data. Boone, Dunklin, Jackson (A. N. Caudell in U. S. N. M.), Pemiscot, Pike (WSC) and St. Louis counties.

98. *Anasa repitita* Heid. Common in the southeastern lowlands on *Sicyos*, on which plants the nymphs also feed. Immatures were collected on October 7. Adults have been taken from June 9 to October 7. Buchanan (CMG), Mississippi, Pemiscot and St. Louis counties.

99. *Ceraleptus americanus* Stal. This common species should occur throughout the southern two-thirds or more of the state. Adults hibernate under rocks, logs, boards and in grass clumps. I took one specimen from beneath a dead cat, but as it attempted to escape immediately on being exposed, I could not determine its relation to the carrion or the many carrion-feeders that were present. Adults have been found the year around. Boone, Pike (WSC), St. Charles and St. Louis counties.

100. *Coriomerus humilis* Uhl. This species has been listed for Florida and Kansas and so probably will be found in Missouri.

101. *Protenor belfragei* Hagl. Although no definite Missouri records are available for this northern species, it might possibly occur here as it has been listed by Blatchley (1926) as ranging "from Quebec and New England west to Colorado and south and west to Maryland and Texas."

102. *Megalotomus quinquespinosus* (Say). This is a common species that should occur throughout the state, being found most commonly in late summer and fall among oak on wooded hillsides. Records of adults extend from May 18 through November 3. Nymphs were collected between June 1 and August 15. Barry (EHF), Boone, Buchanan (CMG), Carter, Cole, Christian, Franklin, Iron, McDonald, Newton (CA), Oregon (WKC), Osage (EHF), Pike (WSC), Pulaski, St. Louis, Shannon, Steelville and Taney (HHK) counties.

103. *Alydus eurinus* (Say). Originally described from "Arkansas and

Missouri" as *Lygaeus eurinus*, this common species will be found throughout the state. Although records show adults from May 18 to November 3, their period of greatest abundance is in late summer and early fall. They are to be found frequently on open ground and on foliage. Fracker's all black variety, *obesa*, far outnumbers the typical form in this state. On one occasion about a dozen specimens were observed probing with their beaks in the exuded grease on a smashed and shriveled toad. VanDuzee (1917) records it correctly for the state. Barry, Boone, Butler, Daviess, Dunklin, Callaway (WRE), Carter, Chariton, Crawford, Harrison, Jefferson, Macon, Maries, Mercer, McDonald, Oregon (WKC), Pemiscot, Pike (WSC), St. Charles, St. Louis, Schuyler and Shannon counties.

104. *Alydus conspersus* Mont. Recorded from both Illinois and Kansas, this species might be found in Missouri.

105. *Alydus pilosulus* (H-S). This common species is undoubtedly of state-wide distribution. It has been taken in greatest abundance from the flowers and foliage of various kinds of plants. Occurence of adults is from May 27 to October 29. Audrain, Barry, Boone, Butler, Cass, Chariton, Jackson, Lafayette, Macon (EHF), Mercer (EHF), Mississippi, Morgan, Osage, Ste. Genevieve and St. Louis counties.

106. *Tollius curtulus* (Stal). This insect has been listed for Kansas and Illinois and so should be found in Missouri.

107. *Stachyocnemus apicalis* (Dall.). I have seen no state specimens of this species, but Heideman (1902) records it from Missouri without definite locality. It is said to occur only in sandy areas. Its range indicates that it should be found in favorable localities throughout the state.

108. *Harmostes fraterculus* (Say). The only available Missouri records are the following three: one in the University of Missouri collection labeled "Columbia, Mo., October 11, 1904"; one swept from a marshy field near Coldwater (Wayne Co.) on September 24; and numerous specimens from the flowers of *Eupatorium* on a gravel-bar in the Current River near Van-Buren (Carter Co.) on August 26.

109. *Harmostes reflexulus* (Say). This common species which occurs throughout the state is found most abundantly on various plants in low moist fields. Adults are found the year around, spending the winter in grass clumps and under logs. Nymphs have been collected from July 22 until September 25. Barry, Boone, Butler, Caldwell, Cape Girardeau, Carter, Chariton, Crawford, Dade, Dallas, Daviess, Dunklin, Harrison, Iron (EHF), Jackson, Jasper, Jefferson, Johnson, Lafayette, Lawrence (WWS), Linn, Macon, McDonald, Mercer, Mississippi, Morgan, Newton (CA), Osage (EHF), Perry, Pike, Polk, Pulaski (EHF), Ste. Genevieve, St. Louis, Shannon, Stone, Taney (HHK), Vernon, Washington and Wayne counties.

110. *Aufeius impressicollis* Stal. An uncommon species that should be found throughout the state. Specimens have been taken from lights, in the

Japanese Beetle Traps in St. Louis and by sweeping in weedy fields. Adult records extend from June 21 to October 25. Boone, Buchanan (CMG), Daviess (EHF), Phelps and St. Louis counties.

111. *Corizus hyalinus* (Fab.). Although this is a common species there are surprisingly few specimens in local collections. Adults have been collected from August 2 through November 3. From August 31 to October 5 nymphs of all stages have been swept from weedy fields. Boone, Carter, Cass (WRE), Chariton (EHF), Cole, Daviess, Harrison, Jefferson, Johnson, Linn, Livingston, McDonald, Mississippi, Morgan (EHF), Osage, Pemiscot, Polk, St. Louis, Shannon and Taney counties.

112. *Corizus sidae* (Fab.). This is apparently a scarce species in the state. In the southeastern lowland section it is found on *Sida*, while in the more northern portion it breeds on *Abutilon*, the Velvet Leaf. Available specimens bear dates falling between the extremes of September 18 and November 5, nymphs being taken at Columbia during early October. Boone, Pemiscot and St. Louis (EPM) counties.

113. *Corizus bohemanii* Sign. This scarce little species has been found ovipositing and feeding on *Monarda bradburiana*. It has also been swept from *Monarda punctata*, black walnut trees and from weedy fields where none of the above mentioned plants were to be found. Adults have been collected from May 12 to July 23 and again from September 7 to 21. Specimens have also been found under mullein leaves in February. This seasonal distribution indicates that adults will probably be found the year around. Hambleton (1908) records this species for the state under a synonym, *Corizus nigristernum*. Butler, Carter, Crawford, Iron, Phelps (EHF), St. Louis and Shannon counties.

114. *Corizus lateralis* (Say). This is by far the most common coreid to be found in the state. Adults have been taken during every month of the year, hibernating in grass clumps and under leaves. The local food plant is the same as that listed in literature, *Polygonum pennsylvanicum* L. Nymphs have been found from early June until late September. It is correctly listed for the state by Uhler (1876) and VanDuzee (1917). Barry, Boone, Buchanan, Butler, Camden, Cape Girardeau, Carter, Cass, Chariton, Cole, Cooper (WRE), Daviess, Harrison, Henry, Holt, Jasper, Lafayette, Lawrence (WWS), Lincoln, Linn, Macon, Maries (EHF), McDonald, Mississippi, Morgan, Nodaway (EHF), Osage, Ozark, Perry, Pettis (WRE), Pike, Polk, Ste. Genevieve, St. Louis, Schuyler, Shannon, Stoddard, Stone, Taney and Texas (EHF) counties.

115. *Leptocoris trivittatus* (Say). This, the well-known "Box-elder bug," was originally described from Missouri as *Lygaeus trivittatus*. It is undoubtedly state-wide in its distribution. Adults have been taken during every month of the year. The winter is spent in hiding under loose bark or in crevices in rocky bluffs. In fall, when searching for a place to hibernate, it often enters buildings in large numbers. When it thus enters homes it causes no trouble to the house-

holder other than that due to its actual presence. Uhler (1876), VanDuzee (1917) and TorreBueno (1941) all list it correctly for the state. Bates, Boone, Buchanan (CMG), Greene (HHK), Lincoln, Mississippi (WSC), Pike (WSC), Randolph, Saline, St. Clair, St. Louis, Stoddard and Taney (HHK) counties.

116. *Jadera haematoloma* (H-S). This apparently very scarce species should be found in all portions of the state. All available specimens were taken in July between the 7th and 29th. Barry (CA), Boone (TEB), Jackson (Kan. Univ. colln.), Jasper (CA), Lawrence (WWS) and St. Louis counties.

ARADIDAE

During most of the year the members of this family are usually found under bark of trees, logs and stumps where they feed on the fungi that grow there. Some species are associated with certain kinds of trees. This apparent preference is not for the trees themselves but for the fungi that are limited to those trees.

117. *Aradus aequalis* Say. Having been recorded from Illinois and Oklahoma, this species should be found in Missouri.

118. *Aradus crenatus* Say. "Missouri" is listed as the type locality for this species. Although no specimens are at hand, the recorded range indicates that it should be found throughout the state.

119. *Aradus quadrilineatus* Say. This species was originally described from Missouri. VanDuzee (1917) and Parshley (1921) both list it for the state but without definite locality. It seems to be scarce. Available specimens were collected on February 29 and March 15 and 17. Boone (WSC), Pike (WSC) and St. Louis (EPM) counties.

120. *Aradus robustus* Uhl. A rather scarce species that should be found throughout the state. Parshley (1921) lists it for "Kansas City, Mo., IV-28, 1897 (P. J. Hall)." Adults have been collected from October to May. One nymph was taken in company with adults on March 16. Boone (WSC), Dunklin, Pemiscot (EHF) and Pike (WSC) counties.

121. *Aradus duzeei* Bergr. Two specimens represent the only available Missouri material: Columbia (Boone Co.) March 9 (WSC), and Glencoe (St. Louis Co.) May 16.

122. *Aradus cincticornis* Bergr. An uncommon species taken from under bark on dead, white oak trees. It was originally described and apparently recorded only from Alabama. It probably will be found throughout the Ozark portion of the state. Adults have been collected from September 11 to February 12. Boone (WSC), Cole, Dade, Jefferson and Taney counties.

123. *Aradus similis* Say. A very common species that should be found throughout the state. Adults are at hand for the period from October 15 to

March 28. Parshley (1921) lists it for Missouri. Boone, Carter, Crawford, Dade, Jefferson, Miller, Oregon, Phelps, Pulaski, St. Louis, Saline and Shannon counties.

124. *Aradus acutus* Say. A common species that should be found throughout the state. Parshley (1921) lists it for "St. Louis, Mo., II-24, 1876." Adults have been collected between September 24 and May 5. Immatures were found with the adults during the months of December, January and February. Boone, Carter (EHF), Dade, Maries, Oregon, Osage, Phelps (EHF), Pulaski, St. Louis, Shannon and Wayne counties.

125. *Aradus inornatus* Uhl. One specimen was taken from under bark of a pine tree at Fremont (Carter Co.) on March 3 (EHF). Three others were found on a pine stump near Ellsinore (Carter Co.) on May 4.

126. *Aradus cinnamomeus* Panz. This species is listed for Missouri by Uhler (1876), VanDuzee (1917) and Parshley (1921). It should occur throughout the state.

127. *Aradus abbas* Bergr. This is another probable species for the state. Blatchley (1926) gives its range in the United States as "New England west and northwest to Washington and south and southwest to Florida and California."

128. *Aradus lugubris* Fall. Say's synonym of this species, *Aradus rectus*, was described from "Missouri and Florida." Blatchley (1926) cites Say's data and points out the synonymy. *Lugubris* is now known as a more northern species and so may or may not be found in the state.

129. *Aradus niger* Stal. The only state representative available is a brachypterous specimen taken from between two pine slabs that were lying on the ground near Fremont (Carter Co.) on February 2.

130. *Aradus falleni* Stal. Parshley (1921) lists a specimen of this species from "Columbia, Mo., VI-1897 (P. J. Hall.)" One specimen was taken at lights in Poplar Bluff (Butler Co.) on August 2 (EHF).

131. *Neuroctenus simplex* (Uhl.). This very common species was described in part from Missouri under the generic name of *Brachyrhynchus*. It was properly listed for the state by VanDuzee (1917) and Blatchley (1926). Adults have been collected during every month of the year. Barry, Boone, Camden, Carter, Cole, Dade, Henry, McDonald, Monroe, Oregon, Osage, Phelps, Ste. Genevieve, St. Louis, Saline, Shannon and Vernon counties.

132. *Mezira granulata* (Say). A not uncommon species that is sometimes found with *Neuroctenus simplex*. Uhler (1876) lists it for "Missouri" as a *Brachyrhynchus*. VanDuzee (1917) records it correctly for the state. Adults have been collected between the extremes of September 1 and June 22 so they will likely be found the year around. Nymphs have been taken on November 16 and May 4. Barry, Boone, Butler, Carter (EHF), Crawford,

Dunklin, Howard, McDonald, Oregon, Phelps, Pike (WSC), Pulaski, Saline, Shannon and Stoddard (EHF) counties.

133. *Mezira lobata* (Say). A scarce species in this state. It was correctly listed for Missouri by VanDuzee (1917). Adults have been taken in February, March and April. Boone (WSC), Carter (EHF), Dunklin and Saline (EHF) counties.

NEIDIDAE

134. *Jalysus wickhami* VanD. This species has been so recently resurrected from synonymy under *Jalysus spinosus* that most of my ecological data stands under that name. However, from limited observations, both forms seem to be quite similar in habits so the notes for the next species will probably fit equally well for either. This species is slightly more common than the next. Adults have been collected during every month of the year. Barry, Boone, Butler, Caldwell, Callaway (WRE), Camden, Carter, Cass, Chariton, Cooper (WRE), Crawford, Dallas, Daviess, Dent (EHF), Franklin, Harrison, Iron (EHF), Jefferson, Lafayette, McDonald, Morgan (EHF), Nodaway, Osage, Phelps, Randolph, Ste. Genevieve, St. Louis, Shannon, Taney, Texas and Wayne counties.

135. *Jalysus spinosus* (Say). This species is common in woods and fields throughout a large portion of the state. Adults are found the year around, hibernating under leaves and in grass clumps. *Panicum* grasses of several species serve as food for both nymphs and adults. The adults do not confine their feeding to plants. As observed on a back-yard gourd vine, adults of this species may suck the juices of the vine or may impale an aphid on its slender beak, lift it free of the stem and suck the juices of the helpless victim until naught but a shriveled skin remains. On another occasion an adult was seen with its beak inserted in an adult Cecidomyid. Adair, Barry, Boone, Butler, Camden (EHF), Cole, Crawford, Dallas, Franklin, Iron, Lawrence (WWS), Lincoln, McDonald, Morgan (WRE), Pettis (WRE), St. Louis, Saline, Schuyler, Shannon and Wayne counties.

136. *Aknisus multispinus* (Ashm.). An uncommon species taken at lights and swept from weedy fields. Adult records are from August 11 to October 7. It is recorded for the state by VanDuzee (1917) under a synonym, *Jalysus perclavatus*, and correctly by McAtee (1919) and TorreBueno (1941). Boone, Cole, Lafayette and Pemiscot counties.

137. *Neides muticus* (Say). This species has been recorded for Kansas and Illinois and so should be found in Missouri.

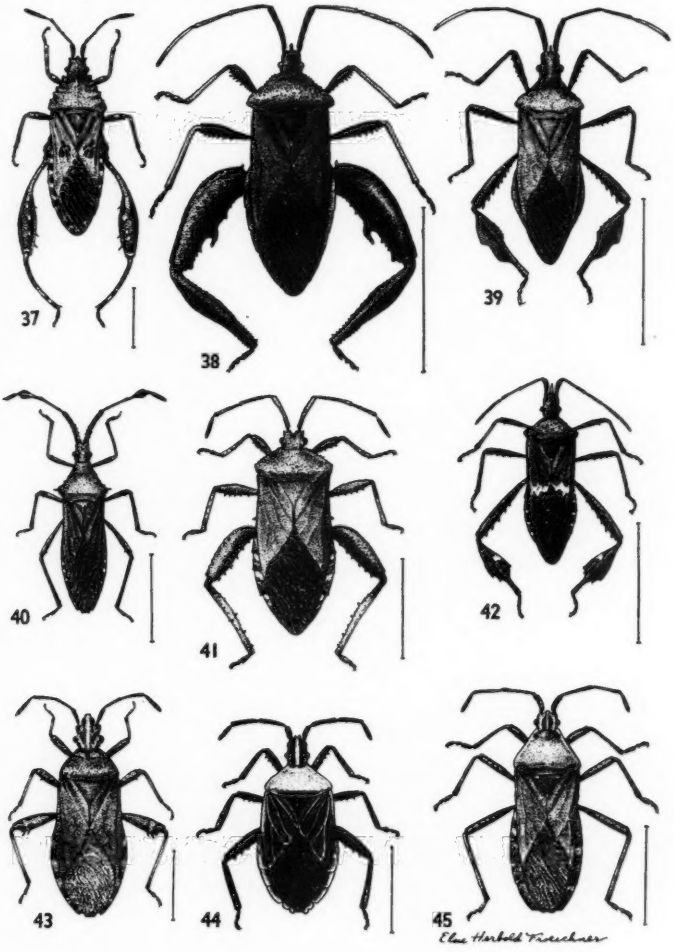

PLATE 4.—Fig. 37. *Merocoris distinctus*. Fig. 38. *Acanthocephala femorata*, male. Fig. 39. *Acanthocephala terminalis*, female. Fig. 40. *Chariesterus antennator*. Fig. 41. *Euthochtha galeator*. Fig. 42. *Leptoglossus clypealis*. Fig. 43. *Ceraleptus americanus*. Fig. 44. *Chelinidea vittiger*. Fig. 45. *Anasa tristis*.

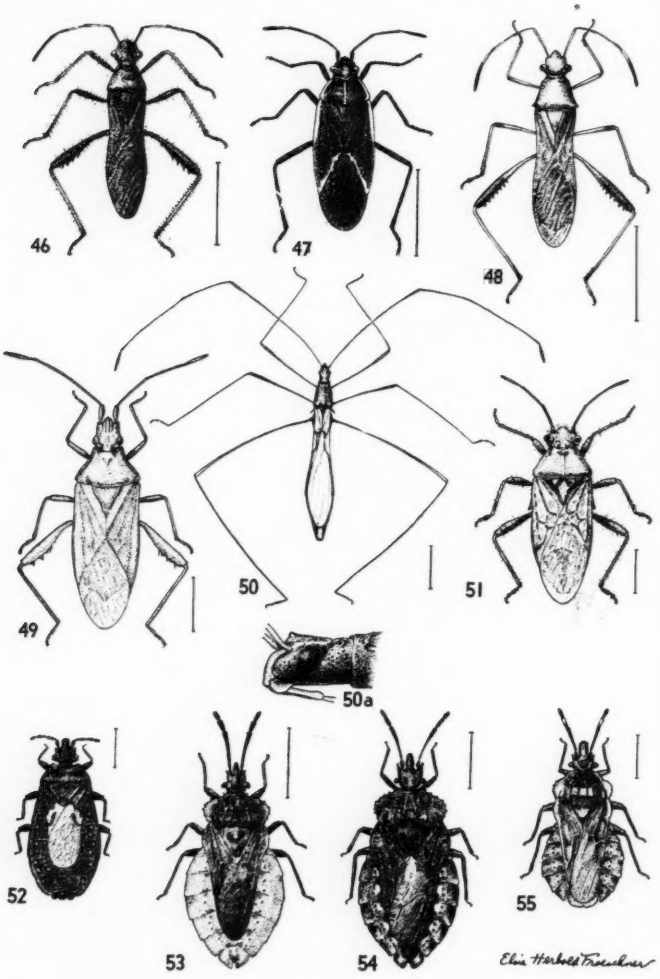

PLATE 5.—Fig. 46. *Alydus eurinus*. Fig. 47. *Leptocoris trivittatus*. Fig. 48. *Megalotomus quinquespinosus*. Fig. 49. *Harmostes reflexulus*. Fig. 50. *Jalysus wickhami*. Fig. 50a. *Jalysus wickhami*, lateral view of head. Fig. 51. *Corizus lateralis*. Fig. 52. *Neuroctenus simplex*. Fig. 53. *Aradus inornatus*. Fig. 54. *Aradus acutus*. Fig. 55. *Aradus cincticornis*.

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Distribution of Sorex cinereus cinereus in Illinois*

E. J. Koestner

The cinereous long-tailed shrew, *Sorex cinereus cinereus* Kerr, is one of the many small mammals of Illinois whose abundance and distribution is not well known. Its infrequent appearance in collections would denote it to be a rare animal, however, exhaustive trapping for long periods and a fuller knowledge of its habits might well change this indication. Occasional records of a large number of individuals taken in one area support this contention. Engels (1931) took eleven individuals of this species in Porter County, Indiana, in one week, where its scattered distribution parallels that in Illinois. Included among the specimens examined for this study were eight taken by E. Heller over a three-day period at Camp Logan, Lake County, Illinois. There are five collected by J. J. Mooney at Deerfield, Lake County, Illinois, which bear the same date. Although the present map (Fig. 1) suggests it to be most abundant in the northern part of the state, this may be due to more collecting in that area.

The cinereous shrew is a common form over the greater part of its geographic range. It will be noted from Jackson's map (1928:39) of its distribution that Illinois, for the most part, is omitted. Thus, the fact that our area lies on the edge of its range makes its distribution in Illinois all the more interesting. In a region so highly subject to changes by agricultural and other practices the distribution of all our mammals is probably constantly changing. Consequently, consideration of dates and numbers of specimens is essential in stating the present distribution. The information given in this paper is but a summary of existing records presented with the hope that field workers will give more attention to this shrew—one of our smallest mammals—so that future students may be able to present a more vivid account.

The writer, while collecting with Richard A. Schneider of Kankakee, Illinois, obtained a specimen of *Sorex cinereus cinereus* (No. 291 of the author's collection) eight miles east of St. Anne, Illinois, on February 11, 1940, in *Andropogon furcatus* prairie not far from oak woods (Koestner, 1941). This record marks the first appearance of the shrew in Kankakee County and the southernmost of the recent and extant specimens from the state. Its sparse and scattered distribution prompted the present summary of existing records for the species in Illinois.

The records of Wood (1910) for McHenry and McLean Counties (W) and of Kennicott (1855, 1858) for Jackson County (R) unfortunately are not supported by existing specimens and would constitute the most interesting of the Illinois records, however, the reliability of these workers is hardly to be questioned. Kennicott also listed the shrew for Cook County, and there are two of his specimens from West Northfield in the U. S. National Museum to support this. Both of these specimens, formerly alcoholics, have

* Contribution from the Zoological Laboratories of the University of Illinois.

been made into skins and now are in very poor condition. Nevertheless their historic value is paramount. Thomas (1861) includes the species in his list of mammals of Illinois. More recent works citing some or all of the specimens here included are Cory (1912), Jackson (1928), Sanborn (1929), Gregory (1936), and Necker and Hatfield (1941). Lyon (1936) lists specimens for counties adjacent to Lawrence and White Counties in Illinois so that it may be expected to be found in these areas (L).

According to the present summary there are fifty-three existing specimens in the following collections:

Chicago Academy of Sciences (A) 23
Field Museum of Natural History (F) 15
Museum of Vertebrate Zoology (V) 6
Department of Zoology, Northwestern University (N) 6
U. S. National Museum (U) 2
Koestner Collection (K) 1

All of these were examined except the six at Northwestern, and information on these was obtained by correspondence.

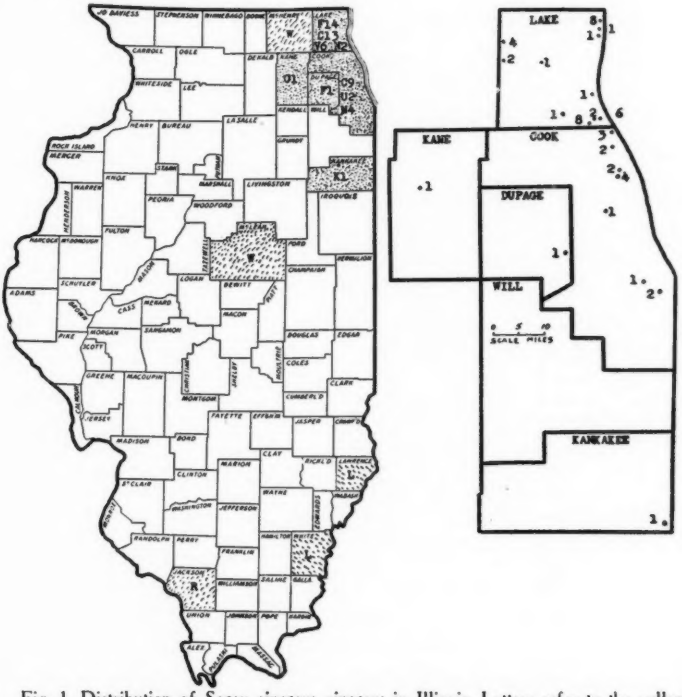

Fig. 1. Distribution of *Sorex cinereus cinereus* in Illinois. Letters refer to the collection or reference as cited in the text. Numbers indicate the number of specimens. The enlarged section shows the exact localities and numbers of existing specimens.

LIST OF SPECIMENS

Cook County. West Northfield 2 U, Catalogued in 1855; River Forest 1 C, 1929; Calumet City 1 C, 1930; Calumet Lake 2 C, 1930; Glencoe 3 C, 1930; Niles Center 2 C, 1931; Chicago 4 N, 1938.

Lake County. Camp Logan 8 F, 1906; Fox Lake 3 F, 1906, 1 N, 1938; Pistakee Bay 2 F, 1928; Lake Forest 1 F, 1929; Prairie View 1 C, 1929; Beach 1 C, 1929; Deerfield 2 C, 1929, 5 C, 1930, 1 N, 1930; Highland Park 1 C, 1929, 1 C, 1930, 6 V, 1938; Grayslake 1 C, 1930; Zion City 1 C, 1930.

Kane County. Bowes 1 C, 1929.

DuPage County. Hinsdale 1 F, 1939.

Kankakee County. St. Anne 1 K, 1940.

Average measurements for the Illinois specimens were taken to correspond with those used by Jackson (1928). Certain measurements taken in the flesh by the collectors were omitted because some error seemed apparent. The first measurement in each of the following sets represents the average for males and the second the average for females. All measurements are in millimeters.

Body Measurements:					
Total length	90.4	88.4	Hind foot	11.2	11.2
Tail length	34.4	34.5			
Skull Measurements:					
Condylobasal length	15.5	15.6	Interorbital breadth	3.4	3.3
Palatal length	6.0	6.1	Maxillary breadth	4.2	4.2
Cranial breadth	7.6	7.5	Maxillary tooth row	5.8	5.7

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Coal-Stripped Land as a Mammal Habitat, With Special Reference to Fur Animals

Lee E. Yeager

Introduction

Coal-stripped land constitutes a recent, widely distributed, biological habitat. Probably not more than 200,000 acres make up this land type, most of which has been created since 1920. The best estimates available indicate that stripmines will never exceed more than a few times their present area, although the coal-stripping industry is now active in some 18 states.[1] The above acreage does not include the open-pit iron mines in Minnesota or the thousands of excavations made for clay and other materials throughout the country. Stripmines occur chiefly in Illinois, Indiana, Kansas, Missouri, North Dakota, and Ohio, but 12 other states have stripped lands of some importance.

Mammalogically, and especially in regard to fur animals, the mine habitat has never been adequately studied. This paper reports on some phases of mammalian utility of this new land type, and is based on a general survey, 1938-1941, rather than on an intensive local study. Illinois stripmines, particularly those in Vermilion County, received most atention, but representative areas in several states were covered during the course of the work.

It is a pleasure to acknowledge the helpful suggestions of E. J. Koestner, Dr. Carl O. Mohr, and Dr. R. E. Yeatter during the preparation of this paper.

Literature

There is only a small literature on the biological aspects of coal-stripped land. Most studies reported to date have been the work of graduate students of the University of Illinois under the direction of Dr. V. E. Shelford. McDougall (1918, 1925) and Croxton (1928) studied strip land from its revegetational aspects. McDougall, interested in plant succession on artificially bared areas, reported on the invasion of both woody and herbaceous plants. Croxton, on a representative area, concluded that excessive acidity, due probably to the disintegration of iron pyrites (FeS_2) exposed in stripping, was a principal factor in retarding vegetation. Smith (1928) published on a careful investigation of the invertebrate life of a stripped area. Costley (1926) studied through one season the higher vertebrates on stripped land of varying age. All of these investigations were conducted in Vermilion County, Illinois.

Leopold (1929), in an unpublished report, wrote, "The stripped lands of

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1 Statement based on information received from various geologists and from numerous geological survey and mining reports.

Illinois are suitable only for reforestation. They will ultimately provide good coverts, but they are mostly located in the sections least in need of additional wooded area. Some of these lands will hold water and can be made to furnish a new kind of artificial marsh land." More recently, Yeager (1940) described the stripmine habitat in generalized terms from the standpoint of wildlife management; and Schavilje (1941) discussed the reforestation of mines in numerous Illinois localities.

Toenges (1939), Bristow (1939), and Moore and Headington (1940) pointed out some of the reclamation possibilities of stripmines, including agriculture, forestry, wildlife, and recreation. In addition, Moore and Headington, using Ohio date, discussed coal stripping from the standpoint of agricultural economics.

The Stripmine Habitat

The physical features of coal-stripped land are especially characteristic (Fig. 1). In the stripping operation the topsoil is usually buried deeply under great, parallel ridges of raw subsoil, shale, and rock. As deposited by gigantic shovels, the "spoil banks" average 20 or 30 feet high and 30 to 50 feet between the long parallel peaks. Very steep slopes are common. Settling is most pronounced the first year or two after mining when packing may lower the "banks" two or three feet or more.

Coal-stripped land offers both terrestrial and amphibious habitats, usually about 80 per cent land and 20 per cent water. Thus, both land and water mammals occur. Forest-inhabiting species naturally are excluded until forest cover has reappeared.

The first trees to invade coal-stripped land are cottonwood *(Populus deltoides)*, willows (*Salix* spp.), maples (*Acer* spp.), elms (*Ulmus* spp.), sycamore *(Platanus occidentalis)*, ash *(Fraxinus americana)*, and box elder *(Acer negundo)*, very probably because their seeds are light and easily wind disseminated. Persimmon *(Diospyros virginiana)* and sassafras *(Sassafras variifolium)* are often found in southern Illinois mines. Common shrubs include elderberry (*Sambucus* spp.), sumac (*Rhus* spp.), wild roses (*Rosa* spp.), hawthorns (*Crataegus* spp.), and dogwoods (*Cornus* spp.). The common vines are trumpet-flower *(Tocoma radicans)*, wild grapes (*Vitis* spp.), moonseed *(Menispermum canadense)*, and in some cases bittersweet *(Celastrus scandens)*. Raspberry (*Rubus* sp.) and other bramble tangles are frequent around mine borders and in the more fertile valleys. In the dissemination of non-winged seed over mined land, the role played by birds and mammals is probably important.

In the central states the first important upland herb invader is white sweetclover *(Melilotus alba)*. This species grows well on a variety of mine sites, but especially so where lime rock is exposed in mining operations. Here, it may reach a height of six feet or more. It does not thrive on the more acid mine peaks. White sweetclover serves to stabilize and build up the disturbed soil

and provides food and cover for birds, rabbits, muskrats, and other animals. Other early invading herbs include certain smartweeds (*Polygonum* spp.), wild lettuce (*Lactuca* spp.), wild parsnips *(Pastinaca sativa)*, ragweeds (*Ambrosia* spp.), foxtail grasses (*Sertaria* spp.), black mustard *(Brassica nigra)*, and various mints, composites, and other forbs.

Aquatic plants generally invade the habitat more slowly than land plants. Cattail *(Typha latifolia)* is the first important species to appear, again probably because the seeds are abundant and easily spread. Quite extensive cattail stands may occur within two or three years after mining. Other species commonly appearing within a few years are musk grasses *(Characeae)*, waterweed *(Elodea)*, and several pondweeds (*Potamogeton* spp.). In Illinois the longleaf pondweed *(P. americanus)* is perhaps most common. Numerous other aquatic plants have been found to grow in mine waters when planted. Stripmine lakes, especially at first, are singularly free of plant debris and animal wastes and

Fig. 1. Air view of a typical stripped area, Vermilion County Illinois. Age, from top to right center, one to more than 50 years. (Photo by U. S. Army Engineers).

Fig. 2. Stripmine about six years old, Vermilion County, Illinois, being invaded by cottonwood, willow, and white sweetclover. Depth of stripping up to 50 feet. (Photo by R. E. Hesselschwerdt).

Fig. 3. Stripmine about 17 years old, Vermilion County, Illinois, showing heavy ground cover of raspberry and wild parsnip, and an open stand of sycamore, box elder, and cottonwood. (Photo by R. E. Hesselschwerdt).

Fig. 4. Stripmine 40-50 years old, Vermilion County, showing a nearly closed stand of white elm, cottonwood, sycamore, box elder, and simliar species. Depth of stripping only about seven feet. (Photo by R. E. Hesselschwerdt).

Fig. 5. A mine about 15 years old, Vermilion County. The bare peaks in the background are highly acid in reaction; white sweetclover on peaks in center and elsewhere in photo. (Photo by George W. Bennett).

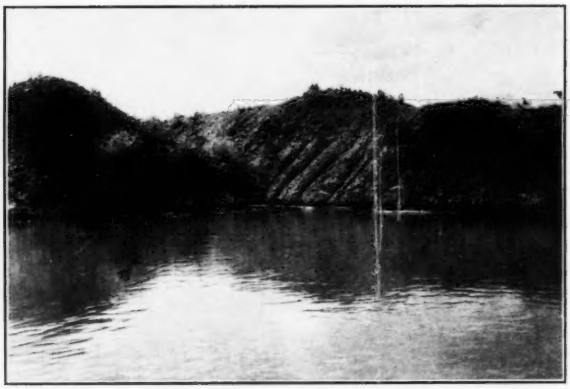

Fig. 6. Peaks about 15 years old, too steep and acid in reaction to permit ready establishment of vegetation. Longleaf pondweed along shoreline; depth of water about 30 feet. Vermilion County. (Photo by George W. Bennett).

Fig. 7. Development of vegetation in "lagoon" between the parallel peaks. Good growth of cattail and white sweetclover, with evidence of muskrat feeding on former in foreground. Vermilion County. (Photo by George W. Bennett).

remains, and probably for this reason seldom support duckweeds or other plants requiring rich concentrations of organic materials in solution.

The absence of large, mature timber on most stripped sites makes for an acute shortage of den trees. Even dead timber suitable for small cavity-nesting mammals and birds is lacking. This problem will be discussed later in this paper.

Animal life appears to include most native forms at one stage of plant succession or another. Mammals are discussed below. Game birds such as pheasants, quail, waterfowl, shore birds, and doves occur in varying densities. A variety of passerine birds are found; herons frequent the older water areas; and raptors both forage and nest on appropriate parts of the habitat. The waters, although in some cases too acid or otherwise unsuitable for fish life, are in others favorable to largemouth black bass, bluegills, crappies, bullheads, and carp; but growth during the first years is likely to be slow, due to low water fertility and resultant food deficiency. Of other vertebrates, no studies of reptiles or amphibians are available, but it is known that some forms of snakes, turtles, and frogs are common.

Mammals

The mammals known to live on or to use the mine habitat include nearly all native species. Mammal occurrence varies from field or open-land forms to such forest inhabitants as squirrels and raccoons. Any given mine area, provided plant development proceeds from bare ground to forest cover, may support mammalian populations beginning perhaps with *Microtus* and cottontail rabbits and ending, in the central states, with gray squirrels and raccoons.

Fig. 8. An acquatic habitat produced by flooding a stripped area, Vermilion County. Depth of mining here only about 10 feet; water not more than four feet deep. (Photo by R. E. Hesselschwerdt).

Were the areas large enough and restocking done, whitetail deer might find the mine habitat tolerable. Beavers have been suggested for willow- and cottonwood-bordered mine waters.

In the aquatic phase of the habitat a smaller number of species is involved. Muskrats may appear within a year or two after mining, after the establishment of food plants. Minks are later attracted; and on the development of suitable vegetation, beavers probably would thrive to the limit of the food supply. It has been demonstrated on numerous areas that mine marshes develop progressively into better muskrat range.

On the basis of succession, it would be possible to list stripmine mammals into three more or less natural divisions, namely, field or open-land, field forest, and forest mammals. However, these categories would overlap considerably; therefore, to suit the purpose of this paper and for convenience the following discussion will be under two main headings — Fur Animals and Non-fur Mammals.

FUR ANIMALS

OPOSSUM, *Didelphis virginiana* Kerr.—No data on the actual density of opossums in the mine habitat are at hand. The best evidence of their presence is tracks which may be found on practically any marshy area or shoreline in both open and reforested mines. This suggests at least common occurrence. Due to the very low fur value during recent years, trappers have made little effort to take opossums, and of those trapped many were taken incidentally in sets made for muskrats. Low hunting pressure appears to have resulted in considerably increased numbers since about 1930.

Opossums do not hesitate to den in the ground when tree cavities or other cover is not available on stripped areas. A number of hunters and trappers have so taken opossums, and I have found several dens showing positive sign (hair and, in some cases, tracks) of use. On the basis of track abundance, the older forested mines are more attractive than newer unforested areas. It is, however, not uncommon to find droppings on bare peaks, sometimes several hundred yards from forest cover, indicating that the animals range over such parts of the habitat. Natural foods occurring on mine areas consist of insects, wild fruits, eggs and nestlings, and such items as crayfish, frogs, and snakes. Fruits and insects have predominated in the droppings examined.

RACCOON, *Procyon lotor* (Linnaeus).—Raccoons range freely over mine marshes and other wasted areas but seldom den on the habitat except where trees have grown sufficiently large to furnish natural cavities. In Illinois only the Vermilion County area, where stripping is said to have begun in 1878, is old enough for this purpose. Only a few stripped areas throughout the mine habitat afford den trees suitable for raccoons. Ground dens here appear to be uncommon.

The development of forests on coal-stripped land, as it relates to raccoons and squirrels, is perhaps of enough interest to warrant further discussion. The Vermilion area, although somewhat atypical for reasons given below, is the

best example at hand of such development. This area lies in the Salt Fork valley and, being mined during the horse-and-scrapper era, was excavated only to a depth of about seven feet, the thickness of the overburden at this site. As a consequence, the peaks are comparatively low, resulting in less rock and shale in the stripping debris and the recovery of more of the top soil. Moreover, the area is subject to flooding and, therefore, enrichment through silt deposition. Because of these factors, a mine site of unusual quality has developed during the 60 years or less since the time of stripping.

A contiguous area of perhaps 40 acres in this vicinity has been studied from the standpoint of stand density and composition. Cottonwood, sycamore, soft maple, willow, and white elm are the most common trees present. A few of these exceed two feet in diameter and many of them are a foot or more. Sycamore and cottonwood show the best growth form, some of these being fairly straight and free of lower branches. Other species, as well as many cottonwoods, are low with bushy, spreading tops. Because of the disproportionately large size of the average crown, this stand is nearly closed, but the number of stems per acre is below that desirable for good stocking. The commercial value, both as to species and timber quality, is comparatively low. Logging would be expensive and difficult when terrain and size of the area are considered.

Cavities presumably quite satisfactory for raccoons are present on this tract, especially in the soft maples. Wood ducks are known to nest here. Cavities of squirrel size are more numerous. As the stand becomes more nearly mature or reaches overmaturity, the number of den sites will undoubtedly be adequate for all wildlife purposes.

A serious shortcoming in present stripmine forests is the almost total absence of nut-bearing trees. Forest succession, even on the area described above, is obviously the early deciduous, river-bottom type, and it is probable that oaks, hickories, walnuts, and perhaps beech, will appear in the later stages. It is only after nut trees appear that stripmines will offer a first-quality squirrel range, as well as improvement over the present raccoon habitat. On the basis of available information, at least a century must elapse before climax forests can be expected, but the appearance of climax species in the stands could undoubtedly be hastened by planting.

On unflooded and therefore more typical mine sites, forest development seems to follow the general order described, but stands are thinner and scrubbier and growth is slower. Because of more recent mining, wherein deeper excavations were made, the terrain here is rougher, a condition that will add to the difficulties of logging. No stands older than about 35 years have been studied on unflooded sites. Here, sycamore showed the best growth form, all other species, even cottonwood, being scrubby. No cavities, or else very few, were present and, of course, nut trees were lacking. The largest trees were cottonwoods and sycamores, some being 15 inches or more in diameter.

In all stripmine stands there is likely to be a scattering of black cherry, box elder, ash, and hackberry trees. A few honey locust measured showed desirable form and excellent growth.

In view of the foregoing, the total mine area now suitable to raccoons and squirrels is indeed very small. It will steadily increase in time, provided plant succession proceeds normally or is accelerated by planting. Although this habitat, because of the small total area, will probably never be particularly significant in the economy of strictly forest mammals, it appears likely to be of appreciable use to a wide variety of forest-edge wildlife.

Raccoons are known to occur in at least two mined areas in Illinois, these being the Vermilion County site described above and along a small creek in Fulton County. In the latter case, the animals den in large trees along the stream where, although surrounded by mines, a narrow strip was not excavated. Tracks on these two areas are common and have been seen in a muddy, heavily-forested flat along the stream and other waters, and at times in cattail marshes at some distance from timber. In a small number of droppings the predominant foods were fruits (wild grapes and black cherries) corn, and crayfish. The presence of corn indicates that racoons denning on mine sites do not obtain full sustenance therefrom.

LONG-TAILED WEASEL, *Mustela frenata* Lichtenstein.—Only a few records of weasel occurrence in mines are at hand, but the species is probably more common than sight and trappers' records indicate. Trappers take comparatively few, since practically all traps are placed in water for muskrats and minks. A weasel was seen on an open site in Fulton County and another on a well-wooded area in Vermilion County. Both records were by competent observers. The writer has seen tracks in both snow and dust under conditions where they could hardly be mistaken for those of mink. A Vermilion County trapper claims to take one or two weasels each year. There is no mine record of the least weasel. The comparative abundance of cottontail rabbits, *Microtus*, and other food, as well as unlimited sites for denning, should qualify much coal-stripped land as good weasel habitat.

MINK, *Mustela vison* Schreber.—Minks are common on some mine areas. During one forenoon in January, 1939, the writer, on snow, located three plainly-used dens on a 15-year-old mine in Vermilion County. These were on a tract of less than 40 acres. A deep mine lake bordered this entire area, and numerous water-containing mine valleys or "lagoons" cut across it. There are no trees here, but there is annually a good cover of white sweetclover, cattails, and other herbaceous vegetation. *Microtus* and muskrats were very common here at the time of this observation. On another area two Vermilion County trappers, over a 10-year period, claimed to have averaged 15 minks per year on a 210-acre mine, of which 100 acres are water. This was during the decade of 1930-40, on a tract stripped 40 or 45 years before.

The mink, being an amphibious species, is dependent on water in mines before such areas became habitable. Seldom does more than 20 per cent of coal-stripped land become water-covered. Of this, some is unattractive from the standpoint of chemical composition due to various, but especially sulfurous, mine wastes. Other water areas are too recently made to support such mink foods as fishes and muskrats, or else await stocking or invasion by these forms.

Comparatively few mines, therefore, afford attractive mink range of sizable acreage. The largest nearly-contiguous area known to the writer involves a total of perhaps 1800 acres in Vermilion County, where a series of dams and subsequent flooding have greatly enlarged and improved the aquatic habitat. It was on a part of this area that the two trappers mentioned above operated.

Practically all strip mine minks use ground dens. A considerable number of these are a few feet to a few rods distant from water, although dens have been found with entrances immediately above the water level. Ground denning is a necessity because of the general absence of logs, stumps, and trees in or near water, except on flooded areas. Even here timber flooded is largely young cottonwood and elm, neither species being given to cavity formation before overmaturity.

Snow tracking has revealed that minks may range freely over the peaks. In many cases such travel is "cross peak," at right angles or otherwise, from one mine marsh or "lagoon" to another. There is considerable evidence of mink predation on *Microtus* in such travels.

SKUNK, *Mephitis mephitis* (Schreber).—As in the case of the opossum and mainly for the same reason, trappers have made comparatively little effort during the last few years to take skunks. Numerous instances of skunks living on stripped land have, however, been found. Their characteristic insect-filled droppings afford the most common sign. The writer has located a number of mine dens, and many such observations have been reported by trappers in Illinois in Vermilion, Fulton, Henry, and Perry counties. Cottage owners in Vermilion County, where mine lands are widely used for recreational purposes, have reported cases of skunk nuisance. As elsewhere, woodchuck holes appear frequently to be utilized as dens, and they may be located on both open and forested mine sites. Skunk populations on areas under observation appear to be increasing.

RED FOX, *Vulpes fulva* Desmarest.—Older mines appear to furnish one of the better red fox habitats on the central prairies. In Vermilion, Fulton, and Henry counties by far the best fox-hunting territory is supplied by this land type. Two hunters reported shooting eight red foxes on Vermilion County strip mines during the winter of 1938-39. A Fulton County mine owner shoots an average of five foxes per year on 600 acres. In May, 1941, a qualified observer reported at least 10 occupied red fox dens on a large stripped area in Henry County. In 1928, Cecil Redmond, Vermilion County, is said to have taken 13 red foxes in traps, chiefly on straw stacks overlooking a large stripped area where the animals denned.

On the black prairies where intensive farming and close grazing have deteriorated the red fox habitat, the strip mines offer by far the best range now available. Indeed, it is difficult to see any special shortcoming in this range. Rabbits and mice are relatively abundant, almost certainly more so than on adjacent farm land. Fruits and insects are likewise available, both on the mine sites, especially mine borders, and on the adjacent hinterland. Cover

and denning grounds are ample and certainly provide whatever seclusion the red fox needs.

A limited amount of tracking on snow showed that the foxes followed trails and the few mine roads which wind in and out of the area. Frequently they walked the crest of a "spoil bank" for some distance, and while they commonly worked the small, scattered cattail marshes, they rarely traveled "cross peak" to them in the manner of minks. In all travels, their frequent use of "sign posts" was obvious. They were traveling in pairs in late January. Dens are usually on the slopes of peaks and have been found in both open and refortested situations. The enlargement and use of woodchuck burrows is probably common.

GRAY FOX, *Urocyon cineareoargenteus* (Schreber).—In the oldest Vermilion County mines, gray foxes are said by experienced local trappers to be as numerous as the reds. There is one record from Saline County in southern Illinois. Attractiveness of the mine habitat to gray foxes will probably increase with the development of forest cover.

COYOTE, *Canis latrans* Say.—The writer has only unverified reports of coyote occurrence in Illinois stripmines, one record being from Perry County. In Kansas and other more western states coyotes are said to be found regularly in the habitat. Such would appear likely, since strip land should have about the same attractiveness for coyotes as for red foxes.

MUSKRAT, *Ondatra zibethicus* (Linnaeus).—The muskrat is by far the most important fur animal found on coal-stripped land. Heavy populations may occur on some mine sites. There are several hundred acres of good 'rat marsh and water in Vermilion County, ranging in age from 10 to 60 years. These areas yield roughly one 'rat fur per acre per year, with some of the best ponds showing a yield of five 'rats per acre per year. This estimate is based on the catch records of five trappers operating on known acreages of marsh, covering periods of five to 14 years. A Henry County trapper took 316 'rats from 80 acres during the season of 1940-41. On the Old Mission Mine in Vermilion County, the Walton brothers estimated that they caught at least 1500 'rats during the decade of 1930 40 on a total of 255 acres of strip land, of which 100 acres are water. The caretaker, Chet Englemann, of the Pollywog Association area in Vermilion County, has averaged about 140 'rats per year from 210 acres of marsh and water over the 14-year period of 1927 to date.

Stripmine 'rats depend almost entirely on bank dens. Only six houses have been seen during three years of observation, and all were in sizable cattail areas. Bank denning is of course strongly influenced by the steep slopes characteristic of mine shorelines where comparatively little area is available for emergent plant growth and house construction. The best cattail stands are usually in the "lagoons," in which water is often not more than two or three feet deep. Even along these long, narrow, cattail beds, bank denning is almost universal, perhaps because of the sharply ascending "spoil banks" which invariably border them. In Henry County, a competent observer (Davidson, 1941)

located 12 dens in active use along a 200-foot stretch of shoreline. Feeding beds are quite common.

The main foods of mine 'rats are cattails, white sweetclover and wild parsnips. The large, fleshy roots of the latter two plants appear to be the chief winter foods. The root of white sweetclover may be an inch in diameter and several feet long; those of parsnips are usually larger and shorter. Scores of observations conclusively show that they may be dug out and eaten by muskrats at any time during the winter that thawing permits. Willow bark is chewed off and probably eaten, especially during the fall. Pondweeds (*Potamogeton* spp.), arrowhead (*Sagittaria* spp.), giant ragweed (*Ambrosia trifida*), water lilies (*Castalia* spp. and *Nymphaea* spp.), and other herbaceous plants are known to be eaten by mine 'rats. No observations of mussels or other animal life being utilized are at hand but such things are undoubtedly taken. In 1939 irrigated rice was planted by the writer in certain stripmine ponds. This grain grew well and produced an abundance of seed. Muskrats utilized it at all stages of growth and continued to feed on the seed late into the winter. Muskrats completely destroyed irrigated rice stands on several artificial lakes in Illinois, and have done great damage to many kinds of aquatic plantings made in stripmine waters. Cypress seedlings, many two-fifths of an inch in diameter, set along stripmine waters in April, 1939 and 1940, were cut off by muskrats. Little if any of the bark was eaten.

On some stripmine areas small ponds may number two or three per acre. Often they are little more than the size of a room, but more often 30 to 100 feet long and several feet wide. Muskrats may find and utilize all or nearly all of them, traveling to and from the separate water bodies by the most direct route. This is usually over and down the "spoil banks," either at right angles or otherwise to their horizontal axis. Very plain, track-padded trails may thus be worn between ponds through the white sweetclover and other cover. Bank dens usually are made on these small water areas. Shorter, equally worn trails directly over spoil banks separating "lagoons" are even more common and afford probably the best sites for trapping mine 'rats.

There is slight evidence that flooding has a seriously adverse effect on muskrats in this habitat. However, most mines are not subject to sudden flooding and in nearly all cases currents are lacking. Because of the irregular shape of water areas and protection given by high banks, wave and wind action are not destructive. Water levels are usually raised by back water, due to the flooding of some nearby stream. A large portion of the Vermilion County mines were so inundated by the Salt Fork River in April, 1939. This rise varied on the stripped area from 5 to 10 feet or more, certainly enough to flood all muskrat dens. Even so, hundreds of peaks and banks were still exposed and an all-day search failed to disclose any muskrats, living or dead. Mine trappers made no mention of decreased 'rat numbers during the season of 1939-40. How many young or mature 'rats that may have drowned in dens during this flood is not known.

On the Old Mission Mine, the owner, about 1925, fenced 20 acres of the best marsh and introduced black muskrats, reportedly from Maryland. During

TABLE 1.—Some Fur Catch Records on Coal-stripped Land in Illinois

Area and County	Acreage			Age at time of Trapping Years *	Period of Continuous Trapping		Average Catch per Year						
	Land	Water	Total		Period	No. of Years	Muskrat	Mink	Raccoon	Opossum	Red Fox	Weasel	Skunk
Old Mission Club, Vermilion	155	100	255	22-60	1930-40	10	150	15	5	10	4	2	10
Sunset Cliff, Vermilion	71	25	96	20-60	1934-41	7	35	1	2	2	0	0	1
Pollywog Association, Vermilion	140	210	360	7-47	1927-41	14	140	4	1	5	0	1	1
North Pollywog Club, Vermilion	180	80	260	7-19	1935-40	5	35	0	0	1	0	0	0
Somers, Fulton	540	60	600	4-12	1939-41	2	50	0	0	0	5†	0	0
Atkinson, Henry	?	80	?	5-10	1940-41	1	316	0	0	0	0	0	0

* Age is based on information supplied by individuals familiar with the areas involved, and is only approximate. Given are age of newest portion of mine at beginning of trapping period, and age of oldest portion at end of trapping period. The average age of each area may be determined roughly by taking the mean of figures.

† Shot on or in immediate vicinity of stripped area.

the next few years some of these 'rats escaped and later the entire colony was released by an unusual flood. Apparently the black 'rats bred with native stock, for many dark individuals were taken by trappers subsequently. Englemann, who traps about one mile distant, says he still catches an occasional dark or black 'rat, but that the number of such forms is decreasing.

TRAPPING AND FUR CATCH

Stripmine trapping differs from other trapping in that practically every trap set is for muskrats, and that other fur animals are taken incidentally. Because minks regularly follow 'rat trails and enter their houses and dens, traps set for 'rats serve almost equally well for this species. Almost all minks trapped in stripmines appear to be so taken. Muskrats and minks make up a very large part of the stripmine catch. During years of normal prices, opossum, skunk, and red fox absorbed some of the trapping pressure, but such conditions have not prevailed since about 1930.

The type of sets made for muskrats and minks in the mine habitat is similar to those made on streams and marshes. Unbaited trail sets, with traps staked in or toward deep water, are standard. Traps are also placed on feeding beds, entrances to dens, on logs and other floating objects (where they occur), and occasionally in overland trails. In the latter case, two traps are often used at each place in the hope of preventing wring-offs. Because of the number and conspicuousness of overland trails, such sets are probably made more commonly than in stream and marsh trapping.

In the foregoing, there are numerous statements relative to fur catches. Table 1 is an attempt to summarize this information and to express it, so far as possible, quantitatively. The age and acreage of land and water is also given for the mines involved. Most of the data were supplied by trappers. In every case, their general accuracy was verified from some other source, except for the Henry County area, the data for which I know are reliable.

No attempt has been made to present the data in Table 1, even for areas of similar age, in such quantitative units as yield per acre. As desirable as such information is, it is impracticable here because of great variation in the intensity of trapping, not only by areas, but on the same area during different years. Also, trappers sought only muskrats, minks, and raccoon. Other species, such as opossum, skunk, weasel, and fox numbers, therefore, were higher on most areas than indicated by the fur catch. Great variation also existed in the trappers. The North Pollywog Club operator was unskilled and erratic, not even aware of the presence of an appreciable number of minks in 1939-40. Conversely, a very capable trapper operated on the Pollywog Association grounds, but during some seasons he trapped only for two or three weeks; others, the entire season. Weather, always an important factor in governing the catch, affects trappers in different ways. Many quit during very cold weather; others leave their traps untended. It is probably safe to say that none of the areas listed was overtrapped; indeed, it is believed that at least four of them could have stood heavier trapping pressure.

TABLE 2.—Comparative Fur Catches in Some Vermilion County, Illinois, Habitats.

Habitat	Type of Trapper	Trapping Ground	Year	No. of Traps	No. of Nights	Catch by Species						
						Muskrat	Mink	Raccoon	Opossum	Red Fox	Weasel	Skunk
Strip-mines	Energetic farm boy	Stripmine lagoons	1938-39	10?	30	34	2	1	0	0	0	0
	Coal miner	Older stripmines	1934-35	59	40	110	1	0	10*	0	0	0
	Coal miner	Older stripmines	1936-37	25	30	60	0	0	0	0	0	0
			1937-38	25	30	55	1	0	0	0	0	0
	Experienced, skillful trapper	Pollywog Association	1934-35	50	40	105	0	0	0	0	0	0
			1935-36	50	40	155	0	0	0	0	0	0
			1936-37	50	40	89	2	1	0	0	0	0
Drainage Ditches	Experienced farmer-trapper	2 miles of ditches	1940-41	75	45	145	7	5	3	1	1	6
	Experienced farmer-trapper	2.3 mi. of ditches	1940-41	50	45	170	2	3	4	2	3	6
	Farmer-trapper	2.5 mi. of ditches	1938-39	100	45	110	10	1	0	0	0	1
Stone Quarry	Caretaker and son	Fairmount Quarry	1935-36	105	25	145	5	6				
	Skillful trapper and leasees	Fairmount Quarry	1936-37	200+	30	600	15	6	"about 20 per year"			
			1937-38	150+	20	250	15	5		"about 15 per year"		
			1938-39	150+	20	250	20	4			"about 5 per year"	"about 20 per year"
			1939-40	200+	40	650	24	6				
	New leasee, good trapper	Fairmount Quarry	1940-41	?	40	350	9	5				
Streams	Very energetic boy	Glenburn Creek	1938-39	36	25	15	1	1	3	1	1	2
	Experienced boy trapper	Middle Fork River	1940-41	18	30	15	0	0	3	0	0	0
	Farmer-trapper	Middle Fork River	1940-41	20	30	20	0	0	0	0	1	0
	Farmer-trapper	Salt Fork River	1940-41	20	20	5	1	0	7	0	2	0

* By night-hunting with dogs.

Due to the variables enumerated, there is only a general correlation between age of habitat and yield. The oldest areas are Sunset Cliff and the Old Mission Club, which show the best raccoon catches. On the Old Mission Club and the Pollywog Association, flooding has produced a superior muskrat habitat due to the creation of sizable marsh areas (Fig. 8). The fur crop here has consistently been harvested by skillful trappers.

To permit comparison of the strip mines with several other Vermilion County habitats, the writer interviewed a number of trappers who have recently operated on mines, drainage ditches, streams, and a large stone quarry. The data, for reasons already listed, are not uniform, but it is believed that they indicate the general quality of the four habitats represented. A larger number of stripmine and drainage ditch trappers could have been included, but it is desired here to present only a few illustrative cases. This information is summarized in Table 2.

There are so many variables in the data given in Table 2 that no attempt is made to present it in more quantitative terms. The chief variations exist in the skill of the trappers and the years trapped, but very important also is the degree of trapping and other events on the several areas during the years immediately preceding the dates given. Finally, the data are trappers' estimates, and while none of doubtful nature was included, I am unwilling to use them for more than obvious conclusions.

It is apparent that the older stripmines, the drainage ditches, and the quarry are relatively good muskrat and mink habitats, and that the streams are inferior. This, however, is not a conclusion applicable to all central and eastern Illinois streams, since those involved, although non-intermittent, are subject to extreme fluctuations in level, and are the precipitous, woodland- and pasture-bordered type, quite unlike many low-banked, cornfield-bordered waterways found on the black prairie. On these wooded streams, even natural foods such as cattails and bulrushes are scare, and cornfields are generally lacking. These factors combine to make the streams in question low-quality muskrat range at the points trapped. Stripmine waters by contrast are comparatively stable, and those involved in Table 2 possess considerable marsh area.

It should carefully be noted that the Vermilion County stripmines offer a fur animal range superior to that of stripped land in most localities, both because the area of comparatively old mines is larger and because an appreciable acreage has been improved by flooding. It should be realized, too, that many mines are not capable of being flooded except at great expense; hence, are not subject to development into productive aquatic areas.

The three drainage ditch catches indicate the superiority of this type for muskrats. No conclusion, of course, can be drawn from this record, but recent Illinois studies (Brown and Yeager, unpublished) amply verified the trend shown here.

The stone quarry is in many ways similar to the stripmines. The main water area at the Fairmount site is about 20 years old, but many of the bays and arms were excavated more recently. The total acreage is about 600 acres, including some timberland. Water covers about 250 acres and roughly indi-

cates the extent of excavation. The water is very clear and is said to reach depths of 20 feet or more at some points. Some of the shoreline is steep or even precipitous, and much of it is strewn deeply with limestone debris. There is considerable shallow water, a part of which overlays solid rock. Musk grass is abundant and a few other submerged species occur. Emergent vegetation consists chiefly of the ubiquitous cattail. White sweetclover grows on some of the banks and adjoining fields. The rock-bound part of the shoreline is lacking in plant life and is of little use to 'rats either as a feeding or denning ground. The most abundant 'rat sign occurs on several narrow excavations leading back into prairie soil.

The data pertaining to the quarry catch were obtained through the courtesy of Lasley Richter, Fithian, Illinois, who held the trapping rights on the area from 1936 to 1940, and who is well informed on the fur animal resources of the quarry and adjoining territory. His explanation of the great fluctuation in the muskrat catch, shown in Table 2, is as follows: The quarry was trapped lightly previous to 1936-37, the first year for which he held trapping rights. Following this year of heavy take, muskrats were comparatively low during the 1937-38 season, and trapping was greatly restricted. Light harvesting was continued through the season of 1938-39. By the fall of 1939 a peak population existed and trapping was intensified. The 650 'rats, 24 minks, and other furs returned an income of nearly $1,000.00 in 1939-40. Except for muskrats, there appears to be more than ordinary uniformity in the quarry catch.

The value of the fur catches under discussion can be estimated at one dollar per pelt for 'rats; five dollars for minks; and about three dollars per pelt for raccoons and red foxes. Opossums and skunks averaged perhaps 20 and 50 cents, respectively.

It will be noted that the most skillful and experienced trappers operated on the best grounds. In the light of a recent Illinois investigation (Brown and Yeager, unpublished), this is not unusual; in fact, it appears to be a nearly universal situation.

NON-FUR MAMMALS

Non-fur mammals, having been given relatively little attention in this study, will receive only nominal discussion. Information presented in such discussions has been drawn from various sources, but chiefly from trappers, other local residents, and club or cottage owners. There is at least one mine record for each species included.

MOLES.—The common or garden mole frequents both open and forested mine sites. Costley (1936) collected *Scalopus aquaticus machrinus* (Raf.) in Vermilion County. Mole runways have been observed on numerous other mined areas. The animals appear to be scarce in the interior of large stripped areas, especially if woody or herbaceous cover is lacking. They apparently are most common in reforested mines or along mine margins adjacent to woodland. The writer has never seen any evidence of occurrence on bare, sun-baked peaks. There is no known record of the star-nosed mole from the habitat.

SHREWS.—The only mine record of shrews at hand is that of Costley (1936), who took one northern short-tailed shrew, *Blarina brevicauda talpoides* (Gapper) in or very near the Vermilion County area. Careful study is likely to disclose additional forms, especially from older mines.

BATS.—These mammals are commonly seen flying over mined areas at night, and the little brown bat, *Myotis lucifugus lucifugus* (LeConte) has been taken on a forested mine in Vermilion County. Several other species undoubtedly occur.

MEADOW-MICE.—The prairie meadow mouse, *Microtus ochrogaster* (Wagner) may be locally abundant in stripmines. In the fall of 1938 heavy populations were noted in Vermilion and Fulton counties, where they apparently reached their greatest density on grass-white sweetclover areas. Trails were plentiful and occurred in the characteristic criss-cross pattern. Evidence was found in snow of both mink and fox predation on these mice, indicating that they contribute importantly in making the mine habitat attractive to predatory species. Mohr (1936, unpublished) took one specimen of the Pennsylvania meadow mouse, *M. p. pennsylvanicus* (Ord), on the Vermilion area.

WHITE-FOOTED MICE.—Costley (1936) reported taking *Peromyscus leucopus noveboracensis* (Fischer) on the Vermilion County area. The prairie white-footed mouse, *P. maniculatus bairdii* (Hoy and Kenn.), has been collected. Cottage and club owners frequently report finding "woods" mice in their buildings.

JUMPING MOUSE, *Zapus hudsonius* (Zimm.).—R. M. Wetzel in 1941 took one jumping mouse on a mine margin in Vermilion County, this specimen now being in the collection of E. J. Koestner.

THIRTEEN-LINED GROUND SQUIRREL, *Citellus tridecemlineatus* (Mitchill).—This ground squirrel has apparently never been collected in the stripmine habitat, but has frequently been seen by the writer in such areas in Vermilion and Fulton counties.

FRANKLIN GROUND SQUIRREL, *Citellus franklinii* (Sabine).—This species also appears never to have been reported from the mine habitat. In late April, 1940, the writer observed a concentration of at least eight individuals along the margin of an old mine in Vermilion County. Other sight records are at hand.

WOODCHUCK, *Marmota monax* (Linnaeus).—Woodchucks may be very common on the older mines. In April, 1939, in Vermilion County, the writer counted 62 woodchuck burrows, or what appeared to be woodchuck burrows, on a tract of about 15 acres partly grown up to white sweetclover. Costley (1936) reported a number of observations, and the writer has seen scores of woodchucks in Vermilion, Fulton, Perry, Henry, and other Illinoiis counties, as well as in strip mines in other states. In this habitat, as in others, woodchuck burrows appear to serve as dens for skunks, opossums, and other species, including rabbits during periods of severe weather.

EASTERN CHIPMUNK, *Tamais striatus* (Linnaeus). — Costley (1936)

reported the collection of *T. striatus* from Vermilion County mines. The writer has only one sight record for eastern chipmunk in the habitat, this being in the same county on the margin of an old mine, June, 1940. This species is probably relatively common in the older and more heavily timbered mines, and are so reported by local residents and trappers.

FLYING SQUIRREL, *Glaucomys volans* (Linnaeus).—I have only one sight record, November, 1939, from Vermilion County. Others have been reported to me by club owners or caretakers. Englemann, of the Pollywog Association, claims that they nest in dead snags still standing on a large flooded area. In at least two cases such snags were entirely surrounded by water, indicating that flying squirrels under these conditions almost certainly glide to and from their nest trees.

GRAY SQUIRREL, *Sciurus carolinensis* Gmelin.—Gray squirrels have been observed in the oldest forested mine regions of Vermilion County. The forest here is of the young flood plain type, trees consisting mostly of cottonwood, sycamore, white elm, soft maple, box elder, black cherry, and white ash. Despite considerable protection, gray squirrels on this area cannot be said to be abundant. A much improved habitat will undoubtedly result when nut-bearing trees appear in these stripmine stands. Tree cavities suitable for squirrel use are available and are most often found in soft maple trees. Spring food in the form of buds and young leaves is abundant.

FOX SQUIRREL, *Sciurus niger* Linnaeus.—Fox squirrels appear on a larger mined acreage than gray squirrels, presumably due to their increased preference for, or tolerance of, open forest conditions. The writer has sight records for Vermilion, Fulton, and Perry counties in Illinois, and Green and Pike counties in Indiana. They occur on stripped land in several other states. Similar to gray squirrels, the habitat will be improved for fox squirrels when acorns, hickory nuts, and other mast is available. Leaf nests known to have been used by fox squirrels have been noted in Vermilion County. An artificial wood duck nest was appropriated by fox squirrels on the Pollywog Association area.

COTTONTAIL RABBIT, *Sylvilagus floridanus* (Allen).—Cottontail rabbit populations in the mines studied varied during the period of 1938 to 1941 from very low to abundant. A census of 467 acres in April, 1939, showed a total of 101 rabbits, or an average of about one per 4.6 acres. A census made at the same time on 1580 acres of farm land adjacent to these mines showed only 91 rabbits, or about one per 17.3 acres. Throughout the prairie district rabbit numbers may be expected to be higher on the older mines than on contiguous farm land, but the opposite probably holds in southern Illinois where a less intensive agriculture and a better upland game habitat are found. On large mines of 200 or 300 acres or more, it has been observed that rabbit populations are usually heavier along the outer margins than in the interior. This appears to be due to the more suitable food and cover conditions found along marginal areas. White sweetclover, bluegrass, and the bark of various shrubs appear to be the staple foods of stripmine rabbits.

Conifer plantations on mines in southern Illinois are at times subject to

severe rabbit injury. A drive in November, 1940, on the Pyramid Mine in Perry County, where injury had been especially noticeable netted over 100 cottontails. The acreage involved in this case is not known.

HOUSE MOUSE, *Mus musculus* Linnaeus.—House mice commonly inhabit cottages on the older mined areas, and are known to occur in a wild state elsewhere in the habitat.

DOGS and CATS.—Feral or free-ranging dogs are numerous in practically all strip mines. The writer has many observations of such dogs running rabbits, digging into burrows, or ranging unrestrained during closed and other seasons. In January, 1939, a free-hunting dog flushed five rabbits on the North Pollywog area in less than an hour; and in April, 1939, another such dog jumped and chased nine rabbits on the same area in less than a forenoon. Dogs hunt this and other mine sites daily. Costley (1936) made a strong point of the probable destructive effect of numerous dogs on strip mine populations; and local residents, with an interest in game, hold similar opinions.

Cats are commonly seen on or near the Vermilion County mines, and, of course, frequent mines elsewhere. Their effect on rabbits, small mammals, and bird life remains unstudied on this land type.

The following common mammals have not been recorded from the stripped habitat during this study: beaver, badger, least weasel, spotted skunk, star-nosed mole, pocket gopher, pine mouse, jack rabbit, cinereous shrew, least shrew, and, it is believed, several species of bats. It is possible that some of these animals do occur, and that others would if mine lands were available in their range.

Wildlife in Stripmine Reclamation

Various utilities—forestry, grazing, recreation, and wildlife—are being suggested in programs aimed at the reclamation of coal-stripped land. In several states, particularly Indiana and Illinois, an appreciable stripped acreage has already been planted to trees. Illinois, Indiana, Kansas, and perhaps other states have recognized the recreational possibilities of the land type and have developed qualified stripped areas into public parks. Grazing is practiced in all states where stripmining has been extensive. Hunting, fishing, and outdoor clubs, as well as private owners, make considerable recreational use of this land type.

Forestry is the most obvious possibility, and plantations up to 15 years are known. Some of these are thrifty, but just what they will ultimately amount to is not known. The average stripmine is often a low-quality forest site, at least for most commercial conifers and climax hardwoods. Black locust grows well, but older plantations may be severely damaged or even killed by the locust borer. Considerable time, at least one tree generation, is likely to be required to build the site to satisfactory producing capacity.

In the management of coal-stripped land, wildlife seems destined to play a leading part. Of such wildlife, mammals are of key importance, since one group or another is adapted to all stages of revegetation. Fish are of major importance where suitable mine waters are found, but even here muskrats and

minks, economically, are of the greatest value. In summary, it can be said that the normal succession of vegetation is prerequisite to the development of commercial forest sites, which probably represent the ultimate development of stripped land from the standpoint of renewable resources. During this process, perhaps a matter of 50, 100, or more years, the various successional stages—herbaceous, shrub, and early forest—will support wildlife populations valuable for recreation, food, and fur. And after the re-establishment of forest cover, wildlife should properly be included in the forest or land management program.

The sanctuary value of stripland should not be forgotten in any evaluation of its utility. This type is obviously difficult to hunt, both because of its rough terrain and because of the frequent impossibility of shots from valley positions. It has been demonstrated repeatedly that pheasants and quail fly into stripped land when hunted on adjacent farmed or wooded areas. Rabbits and foxes offer more strenuous sport here than elsewhere. Over a limited part of the more intensively farmed prairie, these mine lands may provide a ready-made system of refuge areas.

Summary

1. Coal-stripped land constitutes in the central states a small, but unique and recently-created biological habitat.

2. The rugged terrain of the habitat, featured by parallel ridges and valleys, is characteristic. Both land and water types are found, in the ratio of about 80:20 per cent. Light-seeded woody and herbaceous plants are the first invaders on both types. Cottonwood, willow, soft maple, white elm, sycamore, box elder, and white ash are the most important trees in the early forest phase. Of herbs, white sweetclover and cattails are the most important. Succession is roughly similar to that of other areas as to sequence, but is often mixed even on the same area due to variations in the habitat following mining. Succession is slower than on most cleared land because of more adverse soil and site conditions.

3. Mammals of the mine habitat include nearly all native species. Field forms represented by *Microtus* and cottontail rabbits appear first, and such forest species as gray squirrels and raccoons, to date, end the succession. Amphibious mammals, such as muskrats and minks, are present on suitable habitat, which improves with age for these species as well as for fish and waterfowl.

4. Fur animals occurring in stripmines include muskrats, minks, red and gray foxes, opossums, skunks, weasels, coyotes, and raccoons. Muskrats and minks constitute most of the catch and almost all of the income derived. Other fur animals often occur in larger numbers than indicated in catch records.

5. The food of stripmine muskrats, by far the most important fur animal found, consists chiefly of cattails, white sweetclover, and wild parsnips. Probably a miscellany of other matter is taken.

6. Comparative catches on four Vermilion County habitats indicated the superiority of old water-holding mines, drainage ditches, and a large stone

quarry. Streams showed low catches. The first three types were characterized by good food conditions, and the mines and quarry by stable water levels. Streams were subject to extreme fluctuations and produced little food suitable for muskrats.

7. Non-fur mammals for which records are available include the common mole, northern short-tailed shrew, little brown bat, prairie meadow mouse, Pennsylvania meadow mouse, northern white-footed mouse, prairie white-footed mouse, Hudson Bay jumping mouse, thirteen-lined ground squirrel, Franklin ground squirrel, eastern chipmunk, flying squirrel, cottontail rabbit, house mouse, and feral dogs and cats. A number of other forms are undoubtedly present.

8. The sanctuary value of the stripmine habitat for wildlife appears to be considerable.

9. Wildlife, with emphasis on fish and mammals, seems destined to play an important part in the management of stripped land.

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ILLINOIS NATURAL HISTORY SURVEY,
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The Chroococcaceae of Ohio, Kentucky, and Indiana

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While engaged in general research on the taxonomy and morphology of the Chroococcaceae, it was found convenient to study[1] the family in Ohio, Kentucky, and Indiana, both in the field and in the herbarium. An effort was made to assemble and review the material reported in the literature by previous workers; to what extent this project was practicable may be seen in the treatment below.

The Chroococcaceae are those Myxophyceae possessing multicellular (very rarely unicellular) plant-bodies in which the protoplasts are separated from each other by gelatinous material. The cell consists of a protoplast surrounded by the gelatinous material (sheath) which it produces. All the sheaths in one plant, when spoken of together, are here referred to as the gelatinous matrix. The plant may be microscopic, composed of a few to a hundred or more cells; or according to species or age, it may be macroscopic and composed of thousands of cells. Occasionally the protoplasts become smaller in size, especially in old masses growing in subaerial habitats. Changes in appearance of protoplasts and gelatinous matrix may be caused by the growth of fungi in them. Reproduction in the family is by fragmentation. For a discussion of the effects of preservatives on the Chroococcaceae and the preparation of herbarium specimens, see Drouet and Daily, Field Mus. Bot. Ser. 20:67-83 (1939).

It is taken for granted in the keys and descriptions below that determinations cannot be made with accuracy unless well-developed material is studied. Microscopic plants should be numerous in any field of the microscope; all stages in the growth and division of plants and cells can thereby be observed. Measurements and shapes of plants and protoplasts in this treatment apply only to those not in a state of division, unless otherwise stated.

Herbaria and other collections in which specimens cited are to be found

[1] Much of this work was done with the aid of the Garden Club of Cincinnati Fellowship in Botany. I wish to express my appreciation and indebtedness to Dr. J. H. Hoskins for many services and much advice; Dr. Francis Drouet for his many invaluable suggestions and criticisms, and for much encouragement and aid while this study was in progress; the Director and staff of the Field Museum of Natural History for their friendly hospitality; and the following who have sent specimens from their private collections or rendered other kindnesses: Dr. H. Bishop, Dr. A. H. Blickle, Dr. H. C. Bold, Mr. M. Britton, Dr. J. Brunel, Mr. C. G. Chaney, Mr. W. B. Cooke, Mr. A. T. Cross, Mrs. F. K. Daily, Dr. G. J. Hollenberg, Dr. W. Kiener, Mr. L. J. King, Mr. R. Kosanke, Dr. J. B. Lackey, Dr. M. S. Markle, Mr. J. Marr, Dr. W. R. Maxon, Dr. B. B. McInteer, Mr. H. Noland, Dr. C. M. Palmer, Mr. H. Phinney, Mr. C. B. Reif, Mr. D. Richards, Mr. J. Rubinstein, Dr. W. G. Solheim, Dr. B. H. Smith, Dr. C. E. Taft, Dr. L. H. Tiffany, Mr. J. Tucker, Dr. L. Walp, and Miss R. Weikert.

are indicated by means of the following abbreviations: C, Herbarium of the University of California; D, Herbarium of Francis Drouet; Da, Herbarium of W. A. Daily; F, Farlow Herbarium of Harvard University; FM, Cryptogamic Herbarium, Field Museum of Natural History; Mo, Missouri Botanical Garden; N, New York Botanical Garden; O, Herbarium of Oberlin College; Ta, the collection of C. E. Taft; U, United States National Herbarium; UC, Herbarium of the University of Cincinnati. Italicized collection numbers unless accompanied by the name of a collector are my own.

No specimens were seen to support the reports of *Tetrapedia Reinschiana, Holopedium obvolutum, Eucapsis alpina, Rhabdoderma lineare, Marssoniella elegans,* and *Dactylococcopsis Smithii* by Tiffany, Ohio Journ. Sci. **21**:117 (1921) and Ohio State University Stone Lab. Contrib. **6**:15, 18, 19 (1934); of *Tetrapedia* sp. by Roach in Ohio Journ. Sci. **36**:257 (1932); of *Marssoniella elegans* by Tiffany & Ahlstrom, ibid. **31**:458 (1931); or of *Synechocystis aquatilus* by Palmer, Butler University Bot. Stud. **2**:130 (1932).

KEY TO GENERA

I. Protoplasts spherical, in division hemispherical or almost so
  Plants never flat plates consisting of single layers of cells arranged in rows in two directions
    Plants many-celled, of various shapes, the gelatinous matrix homogeneous
      Plants planktonic, always microscopic in size ..... *Polycystis*
      Plants attached to a substratum, attaining macroscopic size at maturity.... ..... *Aphanocapsa*
    Plants few-celled or composed of few-celled groups, the gelatinous matrix often lamellose
      Gelatinous matrix remaining hyaline even in age; plants microscopic, solitary or aggregated loosely in strata..... *Chroococcus*
      Gelatinous matrix becoming colored in age
        Plants macroscopic, the cells permanently attached to each other, the spherical or angular groups of cells often arranged in rows in the mass; gelatinous matrix becoming brown or yellow in age..... *Pleurocapsa*
        Plants microscopic, mostly spherical, under favorable conditions growing in aggregations or strata; gelatinous matrix becoming yellow, brown, blue or red in age ..... *Gloeocapsa*
  Plant a flat plate consisting of a single layer of many cells arranged in rows in two directions ..... *Merismopoedia*

II. Protoplasts ovoid or cylindrical, longer than broad except (in some species) after division
  Protoplasts dividing transversely
    Plants several- to many-celled, attaining macroscopic size ..... *Anacystis*
    Plants microscopic, chiefly 1-2-celled
      Sheath, if present, scarcely discernable ..... *Synechococcus*
      Sheaths thick and conspicuous..... *Chroothece*
  Protoplasts dividing lengthwise, distributed in a single or partially double layer in the periphery of the spherical plant
    Gelatinous matrix homogeneous ..... *Coelosphaerium*
    Gelatinous matrix containing conspicuous radial strands extending from the the center to the protoplasts ..... *Gomphosphaeria*

POLYCYSTIS Kütz.[2] Sp. Algar. 210 (1849). *Clathrocystis* Henfr. Trans. Microsc. Soc. London N. S. 4:53 (1856).

Plants of microscopic size, many-celled, planktonic, variable in shape; gelatinous matrix hyaline, unstratified; protoplasts arranged without order within the matrix, spherical or in division almost hemispherical; reproduction by constriction and fragmentation of the plant.

The morphology and taxonomy of the species (as *Microcystis* spp.) have been treated by Drouet and Daily, ibid.—No specimens were seen to support the reports of *Microcystis* sp. by Kraatz, Ohio Journ. Sci. 40:155 (1940), 41:9-10 (1941), by Palmer, Butler University Bot. Stud. 2:128 (1932), by Roach, Ohio State University Bull. 36:257 (1932), and by Henry, Proc. Ind. Acad. Sci. p. 77 (1913); of *M. flos-aquae* by McInteer, Castanea 4:29 (1939), Ohio Journ. Sci. 30:132 (1930), by Tressler, Tiffany & Spencer, ibid. 40:273 (1940), by Chandler, ibid. 40:315 (1940), by Coyle, ibid. 30:28 (1930), by Tiffany, Ohio State University Stone Lab. Contrib. 6:18 (1934); of *M. ichthyoblabe* by Snow, Bull. U. S. Fish Comm. 22:392 (1902); of *M. pulverea* by Coyle, loc. cit.; of *Clathrocystis* sp. by Pieters, Bull. U. S. Fish Comm. 21:68 (1901), by Juday, Proc. Ind. Acad. Sci. p. 123 (1902), by Clark, ibid. p. 145 (1901), and by Vorce, Proc. Amer. Microsc. Soc. 3:57 (1881); or of *C. roseo-perscicina* by Snow, loc. cit.; of *M. marginata* by Tressler, Tiffany & Spencer, loc. cit., by Tiffany, Ohio Journ. Sci. 21:117 (1921), and by McInteer, Castanea, loc. cit. and Ohio Journ. Sci., loc. cit.; and of *M. parasitica* by Smith, Proc. Ind. Acad. Sci. 41:182 (1931). I was unable to find plants of *M. flos-aquae* in the specimen reported by Palmer, loc. cit.

P. AERUGINOSA Kütz. Sp. Algar. 210 (1849). *Microcystis aeruginosa* Kütz. Tab. Phyc. 1:6 (1846). *Clathrocystis aeruginosa* (Kütz.) Henfr. Trans. Microsc. Soc. London N. S. 4:53 (1856).

Plants developing in masses as heavy water-blooms, variable in shape, spherical, ovoid, cylindrical, irregularly lobed, clathrate or torulose; gelatinous matrix evident or inconspicuous externally; protoplasts up to 9 μ broad, blackish in transmitted light, containing pseudovacuoles. Fig. 1.

This is a common plankton alga in ponds, lakes, and sluggish streams of

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2 Kützing, Linnaea 8:372 (1833) based his genus Microcystis upon specimens (in Rijksherbarium at Leiden, the Botanisches Museum at Berlin-Dahlem, and various American herbaria) which prove to be flagellates. In his Tab. Phyc. 1:7 (1845) he transferred to it a heterogeneous lot of species which he arranged in three subgenera: *Microcystis*, containing only flagellates; *Anacystis*, including *A. marginata* Menegh. and a small species of Nostoc; and *Polycystis*, with *P. aeruginosa* Kütz. and *Anacystis elabens* (Menegh.) Setch. & Gardn. The same arrangement of species was employed when he established Polycystis as a genus in Sp. Algar., p. 210 (1849). There is no choice for us but to revert to the usage almost universal before 1900 in referring to the species treated here by the generic name Polycystis.—F. Drouet & W. A. Daily.

Ohio, Indiana, and Kentucky.—No specimens were seen to support the reports of *Microcystis aeruginosa* and var. *major* by McInteer, Castanea 3:35 (1938) and Ohio Journ. Sci. 30:132 (1930), by Tressler, Tiffany & Spencer, ibid. 40:273 (1940), by Smith, Proc. Ind. Acad. Sci. 41:182 (1931), by Chandler, Ohio Journ. Sci. 40:315 (1940), by Lackey, U. S. Pub. Health Rep. 53:2083 (1938), by Palmer, Butler University Bot. Stud. 2:6, 128 (1931, 1932), by Coyle, Ohio Journ. Sci. 30:28 (1930), by Tiffany, Ohio State University Stone Lab. Contrib. 6:17, 18 (1934); and of *Clathrocystis aeruginosa* by Snow, Bull. U. S. Fish Comm. 22:392 (1902). Specimens are included here upon which are based the reports of *Microcystis pseudofilamentosa*, *M. flos-aquae* and *M. aeruginosa* var. *major* by Smith, Proc. Ind. Acad. Sci. 41:182 (1931), and of *M. aeruginosa* by Evermann & Clark, Ind. Dept. Conserv. Publ. No. 7, 2:141 (1920), by Palmer, Butler University Bot. Stud. 2:128 (1932), and of *Coelosphaerium Kuetzingianum* by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934). Specimens other than those cited by Drouet & Daily, loc. cit. are listed below.

Specimens seen: OHIO: OTTAWA COUNTY: near Gibraltar Isle, *Taft & Daily 649A*, July 1940 (Da, FM). *Taft*, 1935 (Da, FM); in Squaw Harbor, near Gibraltar Isle, *Taft & Daily 650*, July 1940 (Da, FM); Haunch's Pond, Middle Bass Island, Smith's Pond, North Bass Island, Terwilliger's Pond, Put-in Bay, *Ahlstrom*, July, Aug. 1932 (Da), artificial pond near Lake Erie, Port Clinton, *F. K. & W. A. Daily 648*, July 1940 (Da, FM). FRANKLIN COUNTY: Scioto River at the Columbus Zoo, *Taft*, Sept. 1940 (Da, FM); Mirror Lake, Columbus, *Runyon*, Sept. 1933 (Da, FM). HAMILTON COUNTY: lake in Burnet Woods, Cincinnati, *Blickle & Daily 104*, Oct. 1939, *F. K. Daily*, Oct. 1940 (Da, FM, N, Mo, C. F, UC); pond in Arlington Cemetery, Cincinnati, *418*, July 1940, *Hoskins & Daily 109*, Oct. 1939, *F. K. & W. A. Daily 741*, Sept. 1940 (Da, FM), *E. Ward*, July 1938 (Da, FM); pond in Spring Grove Cemetery, Cincinnati, *501*, July 1940 (Da, FM); below dam of Sharon Woods Lake, Sharonville, *F. K. & W. A. Daily 743*, Sept. 1940 (Da, FM). AUGLAIZE COUNTY: east end of St. Mary's Lake, *F. K. & W. A. Daily 634, 633*, July 1940 (Da, FM). PUTNAM COUNTY: tow in Auglaize River, Cascade Park near Dupont, *F. K. & W. A. Daily 640*, July 1940, (Da, FM); tow in Yale pond, Delphos, *F. K. & W. A. Daily 635*, July 1940 (Da, FM); pond near Yale Pond, Delphos, *F. K. & W. A. Daily 636*, July 1940 (Da, FM). DEFIANCE COUNTY: tow in canal near locks, Independence State Park, *F. K. & W. A. Daily 642*, July 1940 (Da, FM). SUMMIT COUNTY: Portage Lake south of Akron, *F. K. & W. A. Daily 575*, July 1940 (Da, FM). STARK COUNTY: reservoir, Beach City, *F. K. & W. A. Daily 576*, July 1940 (Da, FM). ATHENS COUNTY: bloom in State Hospital pond, Athens, *Blickle*, Oct. 1941 (Da, FM).—KENTUCKY: BOONE COUNTY: pond near Walton, *E. Ringemann*, Oct. 1940 (Da, FM), *McInteer 652*, Aug. 1929, (Da, FM); Water Supply pond near Walton, *E. Ringemann*, Oct. 1940 (Da, FM). KENTON COUNTY: fish hatchery near Mt. Lookout, Fort Mitchell, *Hoskins & Daily 251*, Dec. 1939 (Da, FM). FAYETTE COUNTY: reservoir, Lexington, *McInteer, Harvill & Daily 845*, Oct. 1940 (Da, FM, McInteer). FULTON COUNTY: Blue Pond, *McInteer 545*, Aug. 1929 (FM); pond on State Highway 94, 12 miles east of Hickman, *McInteer 529*, Aug. 1929 (FM); Glasgow, *McInteer 516*, Aug. 1929 (FM).—INDIANA: CARROLL COUNTY: Lake Freeman, *15*, July 1938 (Da, FM, C, F, Mo, N, Ta), *877*, July 1941 (Da, FM). MARION COUNTY: Bacon's Bog, Indianapolis, *M. E., J. H., F. K., & W. A. Daily 861, 862*, July 1941 (Da, FM); in plankton of White River near Indianapolis, *Palmer*, 1930-31 (FM). KOSCIUSKO COUNTY: Winona Lake, *Palmer B433, B434*, summer 1935 (FM), *B437, B435*, Aug. 1935, near Winona Lake, *Palmer 168J1*, summer 1936 (Da, FM); Lake Papakeechee, *Smith 145*, Sept. 1929 (FM); Lake Winona, *Smith 199*, Sept. 1929 (FM). STEUBEN COUNTY: Crooked Lake, *Palmer B50(4), B50*, Sept. 1933 (Da, FM); Hamilton Lake, *Ahlstrom*, Sept. 1931 (Da). VIGO

COUNTY: St. Mary's Lake, *Smith 393*, Aug. 1930 (FM), *Smith 647*, Aug. 1930 (FM). MARSHALL COUNTY: along eastern shore of Lake Maxinkuckee, *Clark & Evermann 52*, Nov. 1906 (FM, U); Lake of the Woods, northeast of Plymouth, *Clark & Evermann 27*, July 1909 (FM, U).

P. INCERTA Lemm. Forschungsber. biol. Sta. Plön 7:132 (1899). *Microcystis incerta* Lemm. Kryptogamenfl. Mark Brandenb. 3:76 (1907).

Plants sometimes developing as heavy waterblooms, spherical, ovoid or irregularly lobed: gelatinous matrix diffluent at the margin; protoplasts up to 2 μ broad, pale blue-green, containing pseudovacuoles. Figs. 2 and 3.

The pseudovacuoles are often absent in formalin-preserved material. This species is seldom seen in abundance in the plankton in the region.—No specimens were seen to support the reports of *Microcystis incerta* by Palmer, Butler University Bot. Stud. 2:128 (1932), and by Coyle, Ohio Journ. Sci. 30:28 (1930). One collection seen: KENTUCKY: BOONE COUNTY: reservoir at Walton, *Lackey*, summer 1940 (Da, FM).

APHANOCAPSA Näg. Gatt. einz. Alg. 52 (1848).

Plants many-celled, attached to substrata and usually attaining macroscopic size at maturity; gelatinous matrix homogeneous; protoplasts spherical, in division elliptical and almost hemispherical; reproduction by constriction and fragmentation of the plant.

Young plants, detached from the substratum, are often mistaken for species of Polycystis.—No specimens were seen to support the reports of *Aphanocapsa* sp. by Chandler, Ohio Journ. Sci. 40:314 (1940), and by Kraatz, ibid. 40: 155 (1940); of *A. pulchra* and *A. rivularis* by Britton & Smith, Proc. Ind. Acad. Sci. 42:45 (1932) and ibid. 45:61 (1936); of *A. delicatissima* and *A. elachista* by Eddy, Ill. State Nat. Hist. Surv. Bull. 17:211 (1927); of *A. biformis* by McInteer, Castanea 4:28 (1939), and Ohio Journ. Sci. 30:132 (1930); of *A. pulchra* by Coyle, Ohio Journ. Sci. 30:27 (1930); or of *A. delicatissima*, *A. elachista*, and *A. pulchra* by Tiffany, Ohio State University Stone Lab. Contrib. 6:14 (1934). I was unable to find plants of *A. Zanardinii* in the collection reported by Lillick and Lee, Amer. Midl. Nat. 15:715 (1934), and of *A. pulchra* reported by McInteer, Castanea 4:28 (1939) and ibid. 6:8 (1939).

A. GREVILLEI (Berk.) Rabenh. Fl. Eur. Algar. 1:50 (1865). *Palmella Grevillei* Berk. Glean. Brit. Alg. 16 (1833).

Gelatinous matrix hyaline, homogeneous; protoplasts mostly 4—5 μ broad, scattered or closely aggregated, bright blue-green, homogeneous or slightly granular. Fig. 5.

A. Grevillei occurs as indefinite blue-green strata on submersed moss leaves, debris, and wet rocks. Where the plants are subaerial, the protoplasts are much more widely spaced than in submersed plants.—No specimens were

seen to support the reports of this species by McInteer, Castanea 4:28 (1939), and Ohio Journ. Sci. 30:132 (1930), and by Tiffany, Ohio State University Stone Lab. Contrib. 6:14 (1934).

Specimens seen: OHIO: HAMILTON COUNTY: pond in Eden Park, Cincinnati, *F. K. Daily*, Aug. 1940 (Da, FM). ADAMS COUNTY: on moss, near Mineral Springs, *294*, May 1940 (Da, FM). HIGHLAND COUNTY: on moss, Seven Caves State Park, *F. K. & W. A. Daily 313*, June 1940 (Da, FM).—INDIANA: LAWRENCE COUNTY: sink-hole pool, *Palmer 133*, Sept. 1932 (FM).

A. RICHTERIANA Hieron. in Hauck. & Richt. Phyk. Univ. 10:485 (1892).

Gelatinous matrix hyaline, homogeneous; protoplasts mostly 2—3 μ broad, scattered or closely aggregated, blue-green or yellow-green, homogeneous or slightly granular. Fig. 4.

A. Richteriana occurs in indefinite blue-green strata on submersed debris and wet rocks.—The specimen cited here is the one upon which is based the report of *Gloeocapsa purpurea* by Palmer, Butler University Bot. Stud. 2:4 (1931). INDIANA: MARION COUNTY: in pool in an old greenhouse on the Butler University campus, Indianapolis, *Palmer A 39*, May 1930 (FM).

CHROOCOCCUS Näg. Gatt. einz. Alg. 45 (1848).

Plants of microscopic size, several- to many-celled, of diverse shapes, rarely spherical; gelatinous matrix hyaline, homogeneous or laminose, of equal thickness outside the protoplast; protoplasts spherical, hemispherical, or angular; reproduction by constriction and fragmentation of the plant.

The plants are found mixed with other algae on wet objects and in the water.—No specimens were seen to support the reports of *Chroococcus* sp. by Palmer, Butler University Bot. Stud. 2:126 (1932); of *C. pallidus* and *C. purpureus* by Snow, Bull. U. S. Fish Comm. 22:392 (1902); of *C. decorticans* by McInteer, Castanea 4:28 (1939); of *C. dispersus* and *C. minutus* by Eddy, Ill. State Nat. Hist. Surv. Bull. 17:211, 214 (1927); of *C. minutus* by Smith, Proc. Ind. Acad. Sci. 41:181 (1931), by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930), and by Tressler, Tiffany & Spencer, ibid. 40:273 (1940); of *C. varius* by Coyle, ibid. 30:27 (1930); of *C. cohaerens* by Andrews, Proc. Ind. Acad. Sci. p. 378 (1909) and ibid. 36:225 (1926); of *C. dispersus* and *C. giganteus* by Tiffany, Ohio State University Stone Lab. 6:12 (1934). *C. giganteus* reported by Lillick & Lee, Amer. Midl. Nat. 15:746 (1934), is an encysted flagellate.

KEY TO SPECIES

I. Gelatinous matrix at least as broad as the diameter of the cell, inconspicuously if at all stratified; plants strictly planktonic .....*C. limneticus*

II. Gelatinous matrix thin, usually much thinner than the diameter of the cells, conspicuously stratified to homogeneous; plants aquatic or subaerial
Protoplasts up to 11μ broad, the largest in the mass 4—11 μ broad....*C. rufescens*
Protoplasts up to 40μ broad, the largest in the mass 15—40μ broad.....*C. turgidus*

C. LIMNETICUS Lemm. Bot. Centralbl. 76:153 (1898).

Plants strictly planktonic, up to 16-celled; gelatinous matrix broad, homogeneous; protoplasts 5—7 μ broad, homogeneous or granular, blue-green. Figs. 6 and 31.

No specimens were seen to support the reports of *C. limneticus* by Palmer, Butler University Bot. Stud. 2:126 (1932), by Smith, Proc. Ind. Acad. Sci. 41:181 (1931), by Eddy, Ill. State Nat. Hist. Surv. Bull. 17:211 (1927), by Chandler, Ohio Journ. Sci. 40:314 (1940), by Coyle, ibid. 30:27 (1930), and by Snow, Bull. U. S. Fish Comm. 22:392 (1902); of *C. limneticus* and vars. *subsalsus* and *purpureus* by Tiffany and Tiffany & Ahlstrom. Ohio Journ. Sci. 31: 456, 457 (1931), and Ohio State University Stone Lab. Contrib. 6:12, 13 (1934); or of *C. limneticus* var. *distans* by Coyle, loc. cit. The specimen is included here upon which the report of *C. limneticus* by Smith, Proc. Ind. Acad. Sci. 41:181 (1931), is based.

Specimens seen: INDIANA: KOSCIUSKO COUNTY: near Winona Lake, *Palmer 168J1*, summer 1936 (Da, FM); Winona Lake, *Smith 189*, Sept. 1929 (FM).

C. RUFESCENS (Kütz.) Näg. ibid. 46 (1848). *Protococcus rufescens* Kütz. Tab. Phyc. 1:9 (1845). *Pleurococcus rufescens* Bréb. pro synon. in Kütz. loc. cit. (1845).

Plants up to 64-celled; gelatinous matrix homogeneous or lamellose, scarcely evident in some plants; protoplasts 3—11 μ broad, homogeneous to coarsely granulose, blue-green to yellowish or brownish. Fig. 9.

C. rufescens is found on moist objects of various sorts, often in shallow water, and sometimes in a relatively pure state. This species is referred to in recent literature as *C. minutus* (Kütz.) Näg.—Specimens are included here upon which are based the reports of *Gloeocapsa granosa* by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934) and of *C. minutus* by Britton & Smith, Proc. Ind. Acad. Sci. 42:45 (1932), and by Palmer, Butler University Bot. Stud. 3:102 (1934) and ibid. 2:126 (1932).

Specimens seen: OHIO: HAMILTON COUNTY: orifice of drain, University of Cincinnati campus, *Kosanke & Daily 454*, July 1940 (Da, FM); wet moss, Sharon Woods, Sharonville, *307*, June 1940 (Da, FM); near reservoir, Eden Park, *412, 415*, July 1940 (Da, FM); Addyston Pond, Addyston, *163*, Oct. 1939 (Da, FM). ATHENS COUNTY: residues from sides and bottom of State Hospital ponds, Athens, *Blickle*, Oct. 1940 (Da, FM); on sandstone water trough, The Plains, *M. Wright & Blickle*, July 1941 (Da, FM), on rocks in Sugar Creek pond, *L. Mann & Blickle 50E*, May 1941 (Da, FM). GREENE COUNTY: on moist limestone, Clifton Gorge, *Britton*, April 1937 (Da, FM). ADAMS COUNTY: dripping cliff, Steam Furnace, *Britton*, June 1937 (Da, FM). ERIE COUNTY: quarry pool on Kelleys Island, *Taft 13*, July 1938 (Da, FM). WASHINGTON COUNTY: on submerged sandstone rocks in Hocking Sandstone Quarry near Constitution, *H. Noland, F. K. & W. A. Daily 897, 899, 900, 901, 902*, Oct. 1941 (Da, FM). HIGHLAND COUNTY: on limestone near Seven Caves State Park, *Cooke*, Aug. 1932 (Da, FM, UC).—KENTUCKY: WOODFORD COUNTY: wet rock on side of U. S. Highway 68 near Brooklyn Bridge, *McInteer 1137*, 1941 (FM).—INDIANA: CARROLL COUNTY: on moss in seepage, Lake Freeman near Monticello, *F. K. & W. A. Daily 889*, July 1941 (Da, FM); on moss, wet cliff, Lake Freeman, Monticello, *68*, May 1939 (Da, FM); small pool on limestone behind Lake

Shaffer dam, Monticello, *875*, July 1941 (Da, FM); gelatinous mass on Lake Shaffer dam, Monticello, *872*, on Lake Shaffer dam, *878*, July 1941 (Da, FM). SHELBY COUNTY: on moist limestone in quarry, St. Paul, *F. K. & W. A. Daily 887*, Aug. 1941 (Da, FM). PARKE COUNTY: along Sugar Creek, Turkey Run State Park, *Palmer 15*, May 1932 (Da, FM), *Britton & Smith 994*, Sept. 1932 (FM). WAYNE COUNTY: on rocks under water, Elk Falls near Richmond, *King 207*, Sept. 1940 (Da, FM). STEUBEN COUNTY: lake at Nevada Mills, *Palmer B44*, Sept. 1933 (FM). MARION COUNTY: in plankton of White River near Indianapolis, *Palmer*, Sept. 1931 (FM).

C. TURGIDUS (Kütz.) Näg. Gatt. einz. Alg. 46 (1848).
Protococcus turgidus Kütz. Tab. Phyc. 1:5 (1845).

Plants few-many-celled; sheaths conspicuously lamellose to homogeneous; protoplasts 6—40 μ broad, blue-green, violet, yellow, brown, or reddish brown. Figs. 7, 8.

C. turgidus is found in almost pure gelatinous strata on wet objects or mixed with other algae in similar places and in shallow water. Where the plants are planktonic, the cells are dark blue-green and usually few-celled.—No specimens were seen to support the reports of *C. turgidus* by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930), by Andrews, Proc. Ind. Acad. Sci. p. 378 (1909), and ibid. 36:225 (1926), by Coyle, Ohio Journ. Sci. 30:27 (1930), by Smith, Proc. Ind. Acad. Sci. 41:181 (1931), by Riddle, Ohio Nat. 5:268 (1905), by Tressler, Tiffany & Spencer, Ohio Journ. Sci. 40:273 (1940), by Chandler, ibid. 40:314 (1940), or by Tiffany, Ohio State University Stone Lab. Contrib. 6:13 (1934). Specimens are included here upon which are based the reports of *C. turgidus* by Evermann & Clark, Ind. Dept. Conserv. Publ. No. 7, 2:141 (1920), by Palmer, Butler University Bot. Stud. 3:102 (1934), and by Smith, Proc. Ind. Acad. Sci. 41:181 (1931); of *C. turicensis* by Palmer, loc. cit.; and of *C. tenax* and *C. turgidus* by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934).

Specimens seen: OHIO: PERRY COUNTY: in quarry, Rush Creek Clay Company, Junction City, *Hoskins & Blickle*, Oct. 1939 (Da, FM). ERIE COUNTY: on Kelleys Island, *Taft*, July 1938 (Da, FM), *Tiffany*, June 1931 (FM). ADAMS COUNTY: near Mineral Springs, on moss, *298*, on damp rock, *300*, May 1940 (Da, FM); in mud on wet rock cliff, Beaver Pond, *Lillick & Lee 88*, April 1933 (Da, FM, N). HOCKING COUNTY: on sandstone overhang, Cantwell Cliffs State Park, *693, 702, 688, 727, 728, 731*, Aug., Sept. 1940 (Da, FM); wet sandstone, Old Man's Cave State Park, *F. K. & W. A. Daily 511, 527, 534, 535, 544, 548, 553*, July 1940 (Da, FM). HIGHLAND COUNTY: on limestone cliff, Seven Caves State Park, *F. K. & W. A. Daily 322, 332, 334, 336*, June 1940 (Da, FM); near Seven Caves, Cooke, Aug. 1932 (Da, FM). HAMILTON COUNTY: in puddle near reservoir, Eden Park, Cincinnati, *407*, July 1940 (Da, FM); reservoir, Eden Park, Cincinnati, *F. K. Daily*, Aug. 1940 (Da, FM); pond in Eden Park, Cincinnati, *F. K. Daily*, Aug. 1940 (Da, FM).—KENTUCKY: WOLFE COUNTY: sandstone overhang, Torrent, *Kosanke, F. K. & W. A. Daily 468, 470, 471, 475, 478, 482, 484, 486, 493, 494*, July 1940 (Da, FM); sandstone overhang, Tight Hollow near Pine Ridge, *Cross, Tucker & Daily 785*, Sept. 1940 (Da, FM). POWELL COUNTY: sandstone overhang, Natural Bridge State Park, *F. K. & W. A. Daily 372*, June 1940 (Da, FM); on limestone along Sky Bridge Road near Nada, *Cross, Tucker & Daily 830*, Sept. 1940 (Da, FM).—INDIANA: JEFFERSON COUNTY: on limestone cliff, Clifty Falls State Park, *F. K. & W. A. Daily 675, 676*, Aug. 1940 (Da, FM). WAYNE COUNTY: bottom of spray pond, Crystal Ice Company, Richmond, *King 371*, Nov. 1940 (Da, FM); Tufa Falls near Richmond, *King 131*, 1940 (FM); on wall of cave, Elk Falls near Richmond, *King 201*, Sept. 1940 (FM).

MARSHALL COUNTY: Hawks Marsh, Lake Maxinkuckee, *Clark & Evermann 41*, Aug. 1906 (FM, U). VIGO COUNTY: roadside pond, Glen Home, *Smith 101*, July 1929 (FM); pond, Spring Hill, *Smith 136*, July 1929 (FM). STEUBEN COUNTY: as *C. turgidus*, Crooked Lake, *Palmer*, Sept. 1933, as *C. turicensis*, Crooked Lake, Sept. 1933 (FM).

PLEUROCAPSA Thur. in Hauck Meeresalg. Deutschl. u. Oesterr. 515 (1885).

Plant a stratum attaining macroscopic size, composed of small groups of cells which are arranged more or less in vertical rows; gelatinous matrix at first hyaline, becoming yellow or brown in age; protoplasts spherical, in division hemispherical or almost so.

A specimen was not seen to support the report of *Pleurocapsa* sp. by Palmer, Butler Univ. Bot. Stud. 2:129 (1932).

P. varia (A. Br.) Drouet & Daily, comb. nov.

Chroococcus varius A. Br. in Hansg. Pordr. Algenfl. Böhmen 2: 164 (1892).

Plant blue-green or brownish; gelatinous matrix hyaline becoming brownish, often lamellose; protoplasts blue-green, yellowish, or brownish, up to 7 μ broad, homogeneous to granular. Figs. 36 and 39.

This species is found in nearly pure masses or intermingled with other algae on moist objects. When a portion of the stratum is mounted on a slide, the small groups of cells are usually pressed apart; each group has the aspect of a small Chroococcus or Gloeocapsa.—Included here is the specimen upon which is based McInteer's report of *P. minor* in Castanea 6:6 (1941).

Specimens seen: OHIO: FRANKLIN COUNTY: wet cement floor in greenhouse, Ohio State University, Columbus, *F. K. & W. A. Daily 260*, Dec. 1939 (Da, FM), *W. A. Kellerman E5*, winter 1892 (FM). HOCKING COUNTY: sandstone cliff, Old Man's Cave State Park, *F. K. & W. A. Daily 546*, July 1940 (Da, FM). HAMILTON COUNTY: on flower pot in Peterson's greenhouse, Cincinnati, *438*, July 1940 (Da, FM).—KENTUCKY: FAYETTE COUNTY: on concrete aquarium in greenhouse, University of Kentucky, Lexington, *McInteer 1045*, Sept. 1939 (FM). WOLFE COUNTY: damp sandstone, Torrent, *Kosanke, F. K. & W. A. Daily 474*, July 1940 (Da, FM). CARTER COUNTY: Carter Caverns, *L. Walp*, fall 1940 (FM).—INDIANA: WAYNE COUNTY: moist walls of tunnels, Richmond, *King 76, 77, 61, 64*, first tunnel, Aug. 1940 (FM). PARKE COUNTY: on sandstone cliff along Sugar Creek northeast of Turkey Run Inn, Turkey Run State Park, *Drouet & Richards 2481*, June 1939 (FM).

GLOEOCAPSA Kütz. Phyc. gener. 174 (1843).

Plants several- to many-celled, typically spherical, ovoid, or subglobose; gelatinous matrix homogeneous to conspicuously lamellose, at first hyaline becoming blue, violet, red, yellow, or brown in age; protoplasts spherical or in division ovoid-hemispherical; reproduction by constriction and fragmentation of the plant.

The species grow in strata on moist objects.—No specimens were seen to support the reports of *Gloeocapsa* sp. and *G. ampla* by Vorce, Proc. Amer. Microsc. Soc. 3:57, 60 (1881); of *G. polydermatica, G. aeruginosa, G. coracina*, and *G. sanguinea* by Andrews, Proc. Ind. Acad. Sci. p. 378 (1909); of

G. fenestralis and *G. punctata* by Snow, Bull. U. S. Fish Comm. 22:392 (1902); of *G. polydermatica* by Evermann & Clark, Ind. Dept. Conserv. Publ. No. 7, 2:141 (1920); of *G. dubia* and *G. gelatinosa* by Coyle, Ohio Journ. Sci. 30:27 (1930); or of *G. gigas* by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930).

KEY TO SPECIES

I. Gelatinous matrix at first hyaline, changing to some shade of red in age....*G. magma*
II. Gelatinous matrix at first hyaline, changing to some shade of blue or violet in age ..... *G. nigrescens*
III. Gelatinous matrix at first hyaline, becoming yellow or brown in age
Protoplasts small, up to 5μ broad ..... *G. aurata*
Protoplasts large, the largest in the mass 8—10μ broad ..... *G. rupestris*

G. MAGMA (Bréb.) Kütz. Tab. Phyc. 1:17 (1845). *Protococcus magma* Bréb. Alg. Falaise 40 (1835).

Plants loosely or closely aggregated in strata; gelatinous material at first colorless, becoming tinged or entirely colored with some shade of red; protoplasts up to 9 μ broad, blue-green to brownish, homogeneous to granular. Figs. 10-12, 17.

G. magma has been seen in this region only on sandstone rocks. When the stratum begins to dry, it becomes scaly and blackish. Protoplasts are shriveled in certain collections; their sheaths become very dark in color and develop numerous projections. Where the plants are parasitized or lichenized the sheaths are in part colored yellowish or brown. The specimen is included here upon which is based the report of *G. granosa* by Lillick & Lee, Amer. Midl. Nat. 15:746 (1934).—Specimens were not seen to support the reports of *G. magma* by Andrews, Proc. Ind. Acad. Sci. 36:225 (1926), or by Evermann & Clark, Ind. State Dept. Conserv. Publ. No. 7, 2:141 (1920).

Specimens seen: OHIO: HOCKING COUNTY: sandstone, Old Man's Cave State Park, *F. K. & W. A. Daily 504, 506, 507, 508, 517, 525, 528, 532, 541, 549, 555, 556*, July 1940 (Da, FM); sandstone, Cantwell Cliffs State Park, *703, 687, 684*, Aug. 1940 (Da, FM), *714, 710, 708, 709*, Sept. 1940 (Da, FM); cliff in Ash Cave State Park, *J. Wolfe*, Oct. 1935 (Da, FM). JACKSON COUNTY: cliff at Rock Run, *J. Wolfe*, Nov. 1935 (Da, FM); sandstone, Rock Run, *Cooke*, May 1937 (Da, FM); Whites Gulch, *Britton*, May 1936 (Da, FM).—KENTUCKY: WHITLEY COUNTY: on wet moss, Cumberland Falls State Park, Cumberland Falls, *Lillick*, May 1933 (Da, FM). WOLFE COUNTY: sandstone, Tight Hollow near Pine Ridge, *844*, Oct. 1940, *F. K. & W. A. Daily 848, 851, 852, 853*, May 1941, *Cross, Tucker & Daily 769a, 770, 771, 772, 776, 781, 783, 784, 787, 788, 790, 798, 800, 801, 805, 814, 815, 817, 819, 822*, Sept. 1940, *839, 840, 840b*, Oct. 1940 (Da, FM); sandstone, Torrent, *Kosanke, F. K. & W. A. Daily 460, 467, 472*, July 1940 (Da, FM). POWELL COUNTY: sandstone, Natural Bridge State Park, *Hoskins*, 1938 (Da, FM), wet rock, *McInteer 1026*, Sept. 1939 (FM), sandstone, *F. K. & W. A. Daily 365, 368, 373, 379, 380, 381, 386, 388, 389, 390, 391, 394, 397, 399, 400*, June 1940, on rock, *F. K. & W. A. Daily 275*, April 1940 (Da, FM), *MacFarland* ex. coll. *McInteer 1088, McInteer 1026*, July 1940, (FM); sandstone at south end of old railroad tunnel on Sky Bridge road near Nada, *Kosanke & Daily 841*, Oct. 1940 (Da, FM).—INDIANA: PARKE COUNTY: sandstone cliff in Turkey Run State Park, *Drouet & Richards 2497*, June 1939 (FM).

G. NIGRESCENS Näg. in Rabenh. Alg. Sachs. 35 & 36:629 (1857).

Plants up to 16-celled; gelatinous matrix colorless at first, blue, violet, or blue-black in age; protoplasts blue-green, up to 5 μ broad, homogeneous or slightly granular. Fig. 13, 14, 37.

G. nigrescens is found in strata on limestone and sandstone rocks. It is referred to in recent literature usually as *G. atrata* Kütz. The specimen is included here upon which is based the report of *G. atrata* by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934).

Specimens seen: OHIO: OTTAWA COUNTY: on limestone, Kelly Isle Quarry near Marblehead, Catawba Island, *F. K. & W. A. Daily 578*, July 1940 (Da, FM). HIGHLAND COUNTY: limestone, Seven Caves State Park, *F. K. & W. A. Daily 320, 321*, June 1940 (Da, FM), near Seven Caves State Park, *Cooke*, Aug. 1932 (Da, FM). ATHENS COUNTY: on sandstone, The Plains near Athens, *M. Wright & Blickle*, July 1941 (Da, FM). HOCKING COUNTY: sandstone, Cantwell Cliffs State Park, *F. K. & W. A. Daily 699*, Aug. 1940 (Da, FM).—KENTUCKY: WOLFE COUNTY: on sandstone, Torrent, *Kosanke, F. K. & W. A. Daily 479*, July 1940 (Da, FM). POWELL COUNTY: on sandstone, Natural Bridge State Park, *F. K. & W. A. Daily 374*, June 1940 (Da, FM).—INDIANA: PARKE COUNTY: on sandstone cliffs, Turkey Run State Park, *Drouet & Richards 2475* (N, Da, FM), *2487, 2478*, June 1939 (Da, FM). JEFFERSON COUNTY: on moss from limestone cliffs, Clifty Falls State Park, *F. K. & W. A. Daily 671*, on limestone cliff, *F. K. & W. A. Daily 672*, Aug. 1940 (Da, FM).

G. AURATA Stizenb. in Rabenh. Alg. Sachs. 33 & 34:607 (1857).

Plants several- to many-celled; gelatinous matrix colorless at first, becoming brown and yellow in age; protoplasts blue-green, up to 5 μ broad.

G. aurata is found in strata on sandstone and limestone. Fig. 18.

Specimens seen: OHIO: HIGHLAND COUNTY: limestone, Seven Caves State Park, *F. K. & W. A. Daily 333*, June 1940 (Da, FM). HAMILTON COUNTY: stone wall, Eden Park reservoir, Cincinnati, *410*, July 1940 (Da, FM).—KENTUCKY: BOONE COUNTY: sandstone conglomerate near Ohio River, *Tucker & Daily 352*, June 1940 (Da, FM). WOLFE COUNTY: sandstone, Torrent, *Kosanke, F. K. & W. A. Daily 481*, July 1940 (Da, FM).

G. RUPESTRIS Kütz. Tab. Phyc. 1:17 (1849).

Plants several- to many-celled; gelatinous matrix very broad, colorless at first, becoming yellow or brown in age; protoplasts up to 10 μ broad, blue-green, granular. Fig. 15.

The plants develop in a dark stratum on rocks in this region.—No specimen was seen to support the report of *G. rupestris* by Andrews, Proc. Ind. Acad. Sci. p. 378 (1909).

Specimens seen: INDIANA: PARKE COUNTY: sandstone cliff, Turkey Run State Park, *Drouet & Richards 2498*, June 1939 (FM). JEFFERSON COUNTY: on limestone cliff, Clifty Falls State Park, *F. K. & W. A. Daily 672*, Aug. 1940 (Da, FM).

MERISMOPOEDIA Meyen apud Kütz. Phyc. gener. 163 (1843).

Plant a flat plate, composed of one layer of many cells arranged in rows parallel in two directions; gelatinous matrix homogeneous, hyaline; protoplasts spherical, in division hemispherical; reproduction by fragmentation of

the plant.—No specimens were seen to support the reports of *Merismopoedia* sp, by Pieters, Bull. U. S. Fish Comm. **21**:68 (1902), by Roach, Ohio State University Bull. **36**:257 (1932), or by Krecker, Ohio Journ. Sci. **19**: 454, 455 (1918); of *M. nova* by Vorce, Proc. Amer. Microsc. Soc. **3**:57 (1881); of *M. elegans* by Tiffany, Ohio Journ. Sci. **21**:117 (1921), by Tressler, Tiffany & Spencer, ibid. **15**:273 (1940), or by Chandler, ibid. **40**:314 (1940); of *M. Kuetzingii, M. tenuissima, M. violacea* and *M. elegans* by Snow, Bull. U. S. Fish Comm. **22**:392 (1902); of *M. major, M. elegans, M. punctata,* and *M. tenuissima* by Tiffany, Ohio State University Stone Lab. Contrib. **6**:17 (1934); of *M. tenuissima* by Chandler, Ohio Journ. Sci. **40**:314 (1940), by Tiffany, ibid. **21**:117 (1921), by Tressler, Tiffany & Spencer, loc. cit., by Palmer, Butler University Bot. Stud. **3**:102 (1934), by Britton & Smith, Proc. Ind. Acad. Sci. **45**:61 (1936), by Love & Rogers, ibid. **42**:79 (1932), or by McInteer, Castanea **4**:28 (1939) and Ohio Journ. Sci. **30**:132 (1930); of *M. elegans, M. punctata,* and *M. tenuissima* by Coyle, ibid. **30**:28 (1930); of *M. minima* and *M. punctata* by Smith, Proc. Ind. Acad. Sci. **41**:182 (1931); or of *M. punctata* by Britton & Smith, ibid. **45**:61 (1936), or by McInteer, Castanea, **4**:28 (1939) and Ohio Journ. Sci. **30**:132 (1930).

M. CONVOLUTA Bréb. in Kütz. Spec. Algar. 472 (1849).

Plants blue-green, laminate, circular, rectangular, or polygonal in outline, smooth, undulate, or variously torn and lacerate on the edges, flat or irregularly convolute, up to 5 cm. broad, very thin; protoplasts 3—6 μ broad, blue-green. Fig. 16.

This species is found in shallow water.—No specimens were seen to support the reports of *M. convoluta* by Riddle, Ohio Nat. **5**:268 (1905) and ibid. **3**:317 (1902), or by Andrews, Proc. Ind. Acad. Sci. p. 379 (1909); of *M. convoluta* and var. *minor* by Tiffany & Ahlstrom, Ohio State University Stone Lab. Contrib. **6**:16, 17 (1934) and Ohio Journ. Sci. **31**:457 (1931), or by Brown, Bull. Torrey Bot. Club **35**:248 (1908). Included here is material upon which are based the reports of *M. convoluta* by McInteer, Castanea **4**:28 (1939) and Ohio Journ. Sci. **30**:132 (1930).

Specimens seen: OHIO: LORAIN COUNTY: Oberlin, *F. O. Grover 49*, May 1912 (N).—KENTUCKY: UNION COUNTY: pond at St. Vincent, *McInteer 970* June 1938 (FM). PENDLETON COUNTY: pond on U. S. Highway 27, 2 miles south of Falmouth, *McInteer 672*, Aug. 1929 (FM). CLARK COUNTY: pond on U. S. Highway 60, 1 mile east of Winchester, *McInteer 673*, Aug. 1929 (FM).—INDIANA: MORGAN COUNTY: *Palmer M2*, Oct. 1925 (Da, FM).

M. GLAUCA (Ehrenb.) Kütz. Phyc. germ. 142 (1845). *Gonium glaucum* Ehrenb. Infusionsth. 58 (1838).

Plants rectangular, composed of 4, 16, or 32 cells, blue-green; protoplasts up to 4 μ broad, blue-green, homogeneous. Fig. 32.

M. glauca is found in shallow muddy water in puddles and creeks, not commonly in the plankton. In collections long stored in liquid the gelatinous matrix often disappears and the cells become dissociated. Though the proto-

plasts are of similar size in each plant, they differ greatly in size in various plants of many collections. Those with smaller protoplasts are often referred to in recent literature under the name of *M. tenuissima* Lemm.—No specimens were seen to support the reports of *M. glauca* by Coyle, Ohio Journ. Sci. 30:28 (1930), by Eddy, Ill. State Nat. Hist. Bull. 17:218 (1927), by Snow, Bull. U. S. Fish Comm. 22:392 (1902), by Andrews, Proc. Ind. Acad. Sci. p. 379 (1909), by Riddle, Ohio Journ. Sci. 5:268 (1905), by Chandler, ibid. 40:314 (1940), by Riddle, Ohio Nat. 3:317 (1902) and ibid. 5:268 (1905), by Tiffany, Ohio Journ. Sci. 21:117 (1921) and Ohio State University Stone Lab. Contrib. 6:17 (1934), or by Tressler, Tiffany & Spencer, Ohio Journ. Sci. 40:274 (1940), and by Lillick & Lee, Amer. Midl. Nat. 15:716 (1934). I was unable to find plants of *M. glauca* var. *fontinalis* in the specimens reported by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930). The specimens are included here upon which are based the reports of *M. punctata* and *M. glauca* by Lillick & Lee, Amer. Midl. Nat. 15:716 (1934), by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1932), and by Smith, Proc. Ind. Acad. Sci. 41:182 (1931); of *M. elegans* by Smith, loc. cit.; and of *M. glauca* by Evermann & Clark, Ind. State Dept. Conserv. Publ. No. 7, 2:142 (1920), by Palmer, Butler University Bot. Stud. 3:102 (1934), and ibid. 2:128 (1932); and by Smith, loc. cit.

Specimens seen: OHIO: HAMILTON COUNTY: pond in Lakeview Fish Hatchery, Cincinnati, *434*, July 1940 (Da, FM); culture in greenhouse, University of Cincinnati, Cincinnati, *Lillick & Lee 603*, Feb. 1934 (Da, FM); Big Miami River, North Bend, Fink, Aug. 1932 (Da, FM). WARREN COUNTY: soft muddy layer on limestone in Bear Creek near Foster, *Hoskins & Daily 230*, Nov. 1939 (Da, FM). LORAIN COUNTY: Rice's greenhouse, Oberlin, *O. F. Curtis 49*, March 1912 (O). MERCER COUNTY: Beaver Creek west of Celina, *Lackey*, Aug. 1940 (Da, FM).—KENTUCKY: BARREN COUNTY: pond at Kentucky Utility Company at Glasgow, *McInteer 490*, June, 1929 (FM); pond on U. S. Highway 31, 5½ miles south of Glasgow, *McInteer 612*, Aug. 1929 (FM). HOPKINS COUNTY: new reservoir at Earlington, *McInteer 592*, Aug. 1929 (FM). KNOX COUNTY: Dishman Spring Lake at Barbourville, *McInteer 783*, June 1930 (FM). CHRISTIAN COUNTY: Salubria Springs near Pembroke, *McInteer 559*, Aug. 1929 (FM).—INDIANA: KOSCIUSKO COUNTY: Lake Papakeechee, *Smith 146*, Sept. 1929 (FM). VIGO COUNTY: Wabash River, *Smith 406*, Aug. 1930 (FM); pond 1 mile north of Liggett Creek, *Smith 430*, Aug. 1930; 2 miles north of Forest Park, *Smith 408*, Aug. 1930, *Smith 381*, July 1930; Holman Pond, *Smith 110*, spring 1929; pond, Rose Polytechnic Institute, Terre Haute, *Smith 120*, July 1929 (FM). STEUBEN COUNTY: stream east of Snow Lake, *Palmer*, Sept. 1933 (FM). MARSHALL COUNTY: stratum on bottom by outlet, Lake Maxinkuckee, *Clark & Evermann*, July 1906 (FM, U). MARION COUNTY: in White River near the Indianapolis Sewage Disposal Plant, *Palmer*, May 1931 (FM). WAYNE COUNTY: grown in culture from spray pond, Crystal Ice Company, Richmond, *King 34*, Aug. 1940 (FM).

ANACYSTIS[3] Menegh. Consp. Fl. Eugan. 6 (1837). *Gloeothece* Näg. Gatt. einz. Alg. 57 (1848). *Aphanothece* Näg. ibid. 59 (1848).

[3] Original specimens of *A. marginata* Menegh., type species of the genus, in the Botanisches Museum at Berlin-Dahlem and in the Farlow Herbarium, are well preserved material of the species passing in modern literature under the names *Aphanothece saxicola* Näg. and *Gloeothece confluens* Näg. The generic name *Anacystis* Menegh. antedates *Gloeothece* and *Aphanothece* Näg. Gatt. einz. Alg., pp. 57 and 59 (1848). See also Footnote 2 of this paper.—F. DROUET & W. A. DAILY.

Plants many-celled, attaining macroscopic size; gelatinous matrix homogeneous to conspicuously lamellose, hyaline becoming yellow to brownish in age; protoplasts ovoid, ovoid-cylindrical, oblong-cylindrical, or long-cylindrical, in division spherical or almost so; reproduction by constriction and fragmentation of the plant.

Species of *Anacystis* are found as strata on wet objects or as masses of various shapes in the water. Plants in which the cells are in an active state of division often contain many protoplasts which are almost spherical.—No specimens were seen to support the reports of *Aphanothece* sp. by Eddy, Ill. State Nat. Hist. Surv. Bull. 17:211 (1927), by Chandler, Ohio Journ. Sci. 40:314 (1940), and by Clark, Proc. Ind. Acad. Sci. p. 145 (1901); of *A. clathrata*, and *A. nidulans* by Tiffany, Ohio State University Stone Lab. Contrib. 6:13 (1934); and of *A. stagnina* by Evermann & Clark, Ind. State Dept. Conserv. Publ. No. 7, 2:142 (1920), and by McInteer, Ohio Journ. Sci. 30:132 (1930) and Castanea 4:28 (1939).

KEY TO SPECIES

I. Protoplasts ovoid to oblong-cylindrical, the largest in the mass at most twice as long as broad
  Largest protoplasts in the mass up to 5μ, chiefly 3—4μ broad.....*A. marginata*
  Largest protoplasts in the mass up to 9μ, chiefly 4—6μ broad
    Plant a stratum or a mass of indefinite shape.....*A. rupestris*
    Plant a firm unattached floating sphere .....*A. rupestris* var. *prasina*
II. Protoplasts ovoid to long-cylindrical, often curved, the longest in the mass at least 3 times as long as broad .....*A. Peniocystis*

A. MARGINATA Menegh. loc. cit. (1837).

Plant a stratum or a mass of indefinite shape; gelatinous matrix homogeneous or containing more or less evident lamellose sheaths about the individual protoplasts; protoplasts ovoid or short-cylindrical, up to 5 μ (mostly 3—4 μ) broad, and to almost twice as long, homogeneous, blue-green. Fig. 28.

This species passes in recent manuals under the names *Gloeothece confluens* Näg. and *Aphanothece saxicola* Näg. *A. marginata* occurs often in this region on cement or sandstone rocks, sometimes on debris in the water. — Included here is material upon which are based the reports of *Coelosphaerium Naegelianum* by McInteer, Castanea 6:28 (1939) and of *Gloeothece montana* by Lillick & Lee, Amer. Midl. Nat. 15:716 (1934).

Specimens seen: OHIO: HAMILTON COUNTY: on cement wall, Lakeview Fish Hatchery, Cincinnati, *195*, Oct. 1939 (Da, FM); on stone wall, reservoir, Eden Park, Cincinnati, *408*, July 1940 (Da, FM); wet stone wall under bridge near Addyston, *Lillick & Lee 705*, Sept. 1933 (Da, FM, N, UC). HOCKING COUNTY: on wet sandstone, Old Man's Cave State Park, *F. K. & W. A. Daily 503, 518, 519, 520, 526, 529, 536, 540, 545, 547, 554, 557, 561*, July 1940 (Da, FM); on sandstone, Cantwell Cliffs State Park, *F. K. & W. A. Daily 683, 692, 713, 720*, Aug., Sept.

1940 (Da, FM). OTTAWA COUNTY: in water, quarries near Marblehead, Catawba Island, *F. K. & W. A. Daily 584, 589*, July 1940 (Da, FM); limestone cliff, Gibraltar Isle, *Taft & Daily 665*, July 1940 (Da, FM).—INDIANA: JEFFERSON COUNTY: in shallow water on limestone above falls, Clifty Falls State Park, *F. K. & W. A. Daily 682*, Aug. 1940 (Da, FM). KOSCIUSKO COUNTY: Little Eagle Lake, Winona Lake, *Palmer B-420*, Aug. 1935 (FM).—KENTUCKY: POWELL COUNTY: on wet sandstone near waterfall by old railroad tunnel, Sky Bridge Road, Nada, *Kosanke & Daily 842*, Oct. 1940 (Da, FM); on sandstone wall near Natural Bridge State Park, *F. K. & W. A. Daily 398*, June 1940 (Da, FM). WOLFE COUNTY: wet sandstone overhang, Torrent, *Kosanke, F. K. & W. A. Daily 483, 490*, July 1940; Tight Hollow near Pine Ridge, *Cross, Tucker & Daily 763, 764, 768, 774, 775, 778, 779, 803, 799, 804, 808, 811, 812, 816, 818, 820*, Sept. 1940, (Da, FM). HOPKINS COUNTY: *McInteer 583*, Aug. 1929 (FM).

A. rupestris (Lyngb.) Drouet & Daily, comb. nov. *Palmella rupestris* Lyngb. Tent. Hydrophytol. 207 (1819). *Gloeothece rupestris* (Lyngb.) Born. in Wittr. & Nordst. Alg. exs. 8:399 (1880).

Plant a stratum or floating mass of indefinite shape, blue-green; gelatinous matrix homogeneous, or in many collections the sheaths conspicuous about individual protoplasts, hyaline becoming brownish or yellow in age; protoplasts ovoid or ovoid-cylindrical, often spherical in division, up to 9 μ (mostly 4—6 μ) broad and 12 μ long, homogeneous or granular, blue-green. Figs. 19 and 26.

A rupestris is known in recent literature chiefly under the names *Gloeothece rupestris* (Lyngb.) Born. and *Aphanothece microscopica* Näg. It grows in an infinite variety of habitats. It is probably the most commonly seen of the Chroococcaceae in the region.—A specimen was not seen to support the report of *Gloeothece rupestris* by Tiffany, Ohio State University Stone Lab. Contrib. 6:19 (1934). I was unable to find plants of *G. membranacea* in the collection reported by McInteer, Castanea 4:28 (1939). Specimens are included here upon which are based the reports of *Aphanothece Naegeli, Gloeocapsa granosa, Gloeothece membranacea, G. dubia, G. fuscolutea* and *G. rupestris* by Lillick & Lee, Amer. Midl. Nat. 15:715, 716 (1934), and of *Aphanothece stagnina, Gloeocapsa arenaria, G. muralis, G. polydermatica* and *G. gelatinosa* by Smith, Proc. Ind. Acad. Sci. 41:181, 182 (1931).

Specimens seen: OHIO: HAMILTON COUNTY: culture jar in greenhouse, University of Cincinnati, *735, 736, 738, 739*, Sept. 1940 (Da, FM); greenhouse, University of Cincinnati, *Lillick & Lee*, Mar. 1934 (Da, UC, FM); soil near pond, Addyston, *F. K. & W. A. Daily 167, 171*, Oct. 1939, *345, 346*, June 1940 (Da, FM); wet stone wall under bridge near Addyston, *Lillick & Lee 705*, Sept. 1933 (Da, UC, FM, N); on cement wall and ground, reservoir, Eden Park, Cincinnati, *411, 413, 414*, July 1940 (Da, FM); wet rocks in Eden Park Conservatory, Cincinnati, *180, 181, 183*, Oct. 1939 (Da, FM); damp cement wall in Peterson's greenhouse, Cincinnati, *439, 443, 444*, July 1940, *285, 847*, Apr., Jan. 1941 (Da, FM); rock in falls of Burnet Woods Lake, Cincinnati, *105*, Oct. 1939, *306*, June 1940, *Kosanke & Daily 342*, June 1940 (Da, FM); flower pot, Lakeview greenhouse, Cincinnati, *435*, July 1940 (Da, FM). LORAIN COUNTY: Oberlin, *F. O. Grover 46*, May 1912 (N). VINTON COUNTY: sandstone overhang 5 miles east of McArthur, *121*, Oct. 1939, *Blickle & Kosanke*, June 1940 (Da, FM). ADAMS COUNTY: in mud on wet cliff, Beaver Pond, *Lillick & Lee*

88, Apr. 1933 (Da, FM, UC). ATHENS COUNTY: sandstone rock, Wilsons Farm near Athens, *130*, Oct. 1939 (Da, FM); residues from bottom and sides of State Hospital ponds, *Blickle*, Oct. 1940 (Da, FM); near Canaanville, *Blickle*, July 1941 (Da, FM). GREENE COUNTY: limestone cliff, Clifton Gorge, *Britton*, Apr. 1937 (Da, FM). FAIRFIELD COUNTY: sandstone rock at B. I. S., *J. Wolfe*, Oct. 1935 (Da, FM). HIGHLAND COUNTY: on rock, Seven Caves State Park, *F. K. & W. A. Daily 315*, June 1940 (Da, FM). HOCKING COUNTY: wet sandstone, Old Man's Cave State Park, *F. K. & W. A. Daily 515, 531, 542, 551*, July 1940 (Da, FM); on sandstone overhang, Cantwell Cliffs State Park, *F. K. & W. A. Daily 689*, Aug. 1940 (Da, FM). CUYAHOGA COUNTY: on sandstone cliff at Olmsted Falls, Olmsted, *F. K. & W. A. Daily 564, 565, 566,569, 570, 571, 568, 572*, July 1940 (Da, FM). ERIE COUNTY: on soil, Kelleys Island, *Taft*, 1938? (Da, FM). OTTAWA COUNTY: quarries near Marblehead, Catawba Island, *F. K. & W. A. Daily 577, 591*, July 1940 (Da, FM).—KENTUCKY: POWELL COUNTY: on ledge, Natural Bridge State Park, *272*, Apr. 1940 (Da, FM); limestone cliff along highway near Slade, *Cross, Tucker & Daily 744, 745, 746, 748, 749, 750, 751, 752, 753, 755, 757, 760*, Sept. 1940 (Da, FM); on limestone along Sky Bridge Road, *Cross, Tucker & Daily 825, 827, 829, 834, 836*, Sept. 1940 (Da, FM). WOLFE COUNTY: on wet sandstone, Torrent, *Kosanke, F. K. & W. A. Daily 487, 477, 473, 457*, July 1940 (Da, FM); on sandstone, Tight Hollow near Pine Ridge, *Cross, Tucker & Daily 782*, Sept. 1940, *839a*, Oct. 1940 (Da, FM). FAYETTE COUNTY: jar of water in greenhouse, University of Kentucky, Lexington, *McInteer 1043*, Sept. 1939 (FM).—INDIANA: MARION COUNTY: in laboratory jar, Butler University, Indianapolis, *235*, Nov. 1939 (Da, FM). WAYNE COUNTY: Elk Falls near Richmond, *King 209*, Sept. 1940 (FM); laboratory culture, Earlham College, Richmond, *Markle 5A, 3, 2* (Da, FM). PARKE COUNTY: on wet sandstone cliffs, Rocky Hollow, Turkey Run State Park, *Drouet & Richards 2469*, June 1939 (Da, N, FM); Turkey Run State Park, *Palmer 12*, July 1931 (Da, FM). JEFFERSON COUNTY: damp limestone cliff, Clifty Falls State Park, *F. K. & W. A. Daily 669*, Aug. 1940 (Da, FM). MORGAN COUNTY: on stone tank in greenhouse, *Palmer 150*, Jan. 1934 (FM). VIGO COUNTY: laboratory jar and aquarium, Terre Haute, *Smith 93, 228, 229, 4, 96, 26, 25*, July, Dec. 1929 (FM).

A. rupestris var. **prasina** (A. Br.) Drouet & Daily, comb. nov. *Aphanothece* (*stagnina* var.?) *prasina* A. Br. in Rabenh. Alg. Eur. 57 & 58:1572 (1863).

Plants spherical or ovoid, firm, up to 10 cm. in diameter, otherwise as in the typical variety. Fig. 27.

This variety is found floating in ponds and lakes. It passes under the names *Aphanothece stagnina* (Spreng.) A. Br. and *A. prasina* A. Br. in recent literature. A specimen was not seen upon which is based the report of *A. prasina* by Tiffany, Ohio State University Stone Lab. Contrib. 6:13 (1934).—Included here is the specimen upon which is based Palmer's report of *Aphanothece stagnina* in Butler University Bot. Stud. 3:102 (1934).

Specimens seen: INDIANA: MARION COUNTY: in fish hatchery pond, Indianapolis, *Palmer 72*, Aug. 1931 (Da, FM).

A. Peniocystis (Kütz.) Drouet & Daily, comb. nov. *Gloecapsa Peniocystis* Kütz. Tab. Phyc. 1:25 (1845).

Plant a stratum or floating mass of indefinite shape, blue-green, violet, or gray, soft; gelatinous matrix homogeneous or more or less lamellose, the sheaths evident about the protoplasts in many collections; protoplasts up to

3 μ broad, cylindrical or long-cylindrical with rounded ends, often curved, homogeneous, blue-green or violet. Figs. 29, 35, 38.

A. Peniocystis is found on cement, limestone, and sandstone rocks and floating in the water. It is referred to in recent literature as *Gloeothece linearis* Näg.—The specimens are included here upon which are based the reports of *Aphanocapsa brunnea* by McInteer, Castanea 6:6 (1941), and of *Aphanocapsa elachista* and *Gloeocapsa punctata* by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934).

Specimens seen: OHIO: HIGHLAND COUNTY: on limestone near Seven Caves State Park, *Cooke*, Aug. 1932 (Da, FM, UC). ADAMS COUNTY: on rock cliff, Beaver Pond, *Lillick & Lee 88*, Apr. 1933 (Da, FM, UC). HAMILTON COUNTY: on cement wall in Peterson's greenhouse, Cincinnati, *Blickle & Daily 286, 305*, Apr. 1940, *440, 441*, July 1940, *846*, Jan. 1941 (Da, FM).—KENTUCKY: WOLFE COUNTY: on wet sandstone overhang, Torrent, *Kosanke, F. K. & W. A. Daily 465, 466*, July 1940 (Da, FM); wet sandstone overhang, Tight Hollow near Pine Ridge, *Cross, Tucker & Daily 766, 806, 810*, Sept. 1940 (Da, FM). HART COUNTY: on rock in Mammoth Cave State Park, *McInteer 1074*, June 1940 (FM).—INDIANA: WAYNE COUNTY: on wall of cave, Elk Falls near Richmond, *King 201*, Sept. 1940 (FM). SHELBY COUNTY: on limestone in quarry, St. Paul, *F. K. & W. A. Daily 886*, Aug. 1941 (Da, FM).

SYNECHOCOCCUS Näg. Gatt. einz. Alg. 56 (1848).

Plants 1-2-celled; sheaths if present inconspicuous, thin, hyaline; protoplasts ovoid, cylindrical, or almost spherical, nearly hemispherical in division; reproduction by cell division and fragmentation.

I was unable to find plants of *S. racemosus* in the specimen reported by Palmer, Butler University Bot. Stud. 2:130 (1932). *Synechococcus elongatus* reported by Lillick & Lee, Amer. Midl. Nat. 15:717 (1934), is a bacterium.

S. AERUGINOSUS Näg. loc. cit. (1848).

Protoplasts up to 45 μ long and to 20 μ broad, usually twice (rarely three times) as long as wide, bright blue-green to yellowish, homogeneous to coarsely granular. Fig. 30.

S. aeruginosus is found mixed with other Myxophyceae on wet rocks.

Specimens seen: KENTUCKY: WOLFE COUNTY: on sandstone, Tight Hollow near Pine Ridge, *F. K. & W. A. Daily 849, 854*, May 1941 (Da, FM).

CHROOTHECE Hansg. Oesterr. Bot. Zeit. 34:352 (1884).

Plants 1-several-celled, often growing as uniseriate filaments; gelatinous matrix hyaline, broad, often elongated, stipe-like and lamellose at one end; protoplasts ovoid or cylindrical with rounded ends, spherical or short-ovoid after division; reproduction by fragmentation.

C. MONOCOCCA (Kütz.) Hansg. Prodr. Angenfl. Böhmen 2:134 (1892). *Gloeocapsa monococca* Kütz. Phyc. gener. 175 (1843).

Plants bright blue-green; protoplasts up to 9 μ broad and to twice as long as broad, blue-green, homogeneous. Figs. 22, 33, 40.

C. monococca is found on limestone and sandstone rocks in this region. It is known in recent literature as *C. Richteriana* Hansg.

Specimens seen: OHIO: HIGHLAND COUNTY: on limestone, Cave Canyon, Seven Caves State Park, *F. K. & W. A. Daily 323, 329*, June 1940 (Da, FM).—INDIANA: PARKE COUNTY: on sandstone cliffs, Falls Canyon, Turkey Run State Park, *Drouet & Richards 2473*, June 1939 (FM).

COELOSPHAERIUM Näg. Gatt. einz. Alg. 54 (1848).

Plants microscopic, aquatic, many-celled, spherical, ovoid, or in division variously tuberculose and constricted; gelatinous matrix hyaline and homogeneous; protoplasts arranged in a single (in large plants partially double) layer in the periphery of the plant, ovoid to obcylindrical, the long axes directed toward the center of the plant, dividing lengthwise; reproduction by constriction and fragmentation of the plant.— No specimens were seen to support the reports of *Coelosphaerium* sp. by Palmer, Butler University Bot. Stud. 2:126 (1932), by Coffing, ibid. 4:25 (1937), by Kraatz, Ohio Journ. Sci. 40:155 (1940) and ibid. 41:9, 10 (1941), by Vorce, Proc. Amer. Microsc. Soc. 3:57 (1881), or by Juday, Proc. Ind. Acad. Sci. p. 123 (1902); of *C. roseum* by Snow, Bull. U. S. Fish Comm. 22:392 (1902); of *C. dubium* by McInteer, Castanea 4:128 (1939) and Ohio Journ. Sci. 30:132 (1930); of *C. Naegelianum* by Coyle, Ohio Journ. Sci. 30:27 (1930), or by Kraatz, ibid. 41:11 (1941); or of *C. Naegelianum* and *C. dubium* by Tiffany, Ohio State University Stone Lab. Contrib. 6:15 (1934), or by Chandler, Ohio Journ. Sci. 40:314 (1940). I was unable to find plants of *C. minutissimum* in the specimen reported by Lillick & Lee, Amer. Midl. Nat. 15:715 (1934).

C. Collinsii Drouet & Daily.[4]

Plants growing in shallow water; gelatinous matrix diffluent at the margin; protoplasts 2—4 μ broad and 1½ times as long as broad, ovoid or obcylindrical, circular in end-view, blue-green or yellowish-green, without pseudovacuoles. Fig. 24, 25, 34.

Specimens seen: MAINE: Long Point, Mt. Desert, *Collins 3904*, July 1906 (N).—MASSACHUSETTS: French Watering Place, Naushon Island, Gosnold, *Drouet 2125*, Aug. 1937 (TYPE in herb. F. Drouet); Fresh Pond, Nobska Point, Falmouth, *Drouet 1948*, Sept. 1936 (D).—INDIANA: specimens as listed in the text below.—MONTANA: Middle Quartz Lake, Glacier National Park, *Long F175*, Sept. 1934 (FM).—WYOMING: Fayette Lake, Fremont County, *Bond F268*, Aug. 1934 (FM).—UTAH: Stream Mill Lake and Tony Grove Lake, Cache County, *G. Piranian*, Aug. 1933 (FM).—F. DROUET & W. A. DAILY.

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[4] **Coelosphaerium Collinsii** Drouet & Daily, sp. nov.

Plantae sphaericae vel ovoideae, varie tuberculosae et in divisione constrictae, multicellulares, aerugineae vel luteo-aerugineae, matrice gelatinosa hyalina, firma vel diffluenti; protoplastis in plano peripherico irregulariter distributis, ovoideis vel obcylindraceis aerugineis vel luteo-aerugineis, homogeneis vel subtiliter granulosis, 2—4μ crassis, diametro circa 1½-plo longioribus, axibus ad centrum plantae directis.—The plants are smaller than those of *C. Kuetzingianum* Näg., and their protoplasts contain no pseudovacuoles as do those of the latter species. *C. Collinsii* is named in honor of the late Frank S. Collins.

This species grows among other algae in shallow fresh water, seldom in the plankton; it never develops as heavy water-blooms as does *C. Kuetzingianum*.

Specimens seen: INDIANA: STEUBEN COUNTY: with *Merismopoedia glauca* in Fox Lake, *Palmer 1019*, July 1933 (FM); Crooked Lake, *Palmer B49b*, Sept. 1933 (FM).

C. KUETZINGIANUM Näg. Gatt. einz. Alg. 54 (1848).

Plants planktonic, developing in masses as heavy water-blooms; gelatinous matrix diffluent or (in some collections) firm and conspicuous externally; protoplasts black in transmitted light, coarsely granular with pseudovacuoles (blue-green or yellowish-green in material long preserved in liquid or in masses where the pseudovacuoles have been lost), ovoid-cylindrical, the long axes directed toward the center of the plant, circular in end-view, up to 5 μ broad and to twice as long as broad. Fig. 23.

As in *Polycystis aeruginosa* (see Drouet & Daily, Field Mus. Bot. Ser. 20:67-83, 1939) the appearance of plants of *C. Kuetzingianum* in various collections differs according to the history of the mass and according to the type of treatment received during and after collecting. The name *C. Kuetzingianum* is applied by many modern phycologists to plants which have lost their pseudovacuoles in liquid preservatives; those plants which retain the pseudovacuoles have often been designated by the name *C. Naegelianum* Unger. In many collections stored for a long period in formalin or alcohol, the gelatinous matrix disappears completely and the cells become dissociated. This species grows in the plankton of ponds, lakes, and sluggish streams.—No specimens were seen to support the reports of *C. Kuetzingianum* by Coffing, Butler University Bot. Stud. 3:100 (1934), by Coyle, Ohio Journ. Sci. 30:27 (1930), by Tiffany, Ohio Journ. Sci. 21:117 (1921) and Ohio State University Stone Lab. Contrib. 6:15 (1934), by Tressler, Tiffany & Spencer, Ohio Journ. Sci. 40:273 (1940), by Riddle, Ohio Nat. 3:317 (1902), Eddy, Ill. State Nat. Hist. Surv. Bull. 17:211 (1927), by Snow, Bull. U. S. Fish Comm. 22:392 (1902), or by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930). Included here are the specimens upon which are based the reports of *C. Naegelianum* by Smith, Proc. Ind. Acad. Sci. 41:181 (1931), by Palmer, Butler University Bot. Stud. 3:102 (1934), and by Evermann & Clark, Ind. Dept. Conserv. Publ. No. 7, 2:141 (1920).

Specimens seen: OHIO: HAMILTON COUNTY: water-bloom in Arlington Cemetery brick-yard pond, Cincinnati, *Hoskins & Daily 108*, Oct. 1939 (Da, FM). SUMMIT COUNTY: in Portage Lake south of Akron, *F. K. & W. A. Daily 575*, July 1940 (Da, FM); south reservoir, Portage Lake near Akron, *Ahlstrom*, Aug. 1931 (Da, FM). ATHENS COUNTY: bloom in State Hospital pond, Athens, Blickle, Oct. 1941 (Da, FM). STARK COUNTY: Beach City reservoir, Beach City, *F. K. & W. A. Daily 576*, July 1940 (Da, FM). MEDINA COUNTY: Chippewa Lake, *Ahlstrom*, Aug. 1931 (Da, FM). OTTAWA COUNTY: Lake Erie, *Tiffany*, 1929 (FM).—INDIANA: SULLIVAN COUNTY: Shakamak State Park Lake, *Palmer B18*, Sept. 1933 (Da, FM). KOSCIUSKO COUNTY: Lake Papakeechee, *Smith 145*, Sept. 1929 (FM). VIGO COUNTY: pond at Rose Polytechnic Institute, Terre Haute, *Smith 134*, July 1929 (FM). STEUBEN COUNTY: Hogback Lake, *Palmer 1015*, July 1933 (FM). MARHALL COUNTY: Lake of the Woods, northeast of Plymouth, *Clark & Evermann 27*, July 1909 (FM, U); Lake Maxinkuckee, *Clark & Evermann 52*, Nov. 1906 (FM, U).

GOMPHOSPHAERIA Kütz. Alg. Exsic. Dec. 16:151 (1836).

Plants microscopic, many-celled, spherical or ovoid, variously tuberculose and constricted during division; gelatinous matrix hyaline, the protoplasts enveloped by distinct individual sheaths, each bearing a gelatinous projection at its base and connected with others toward the center of the plant; protoplasts distributed in a single layer in the periphery of the plant, their long axes directed toward the center of the plant, pyriform, obovoid, or obcylindrical, and in division cardioid or obcuneate in lateral view.—No specimens were seen to support the reports of *G. lacustris* by Coyle, Ohio Journ. Sci. 30:28 (1930), by Chandler, ibid. 40:314 (1940), by Palmer, Butler University Bot. Stud. 3:102 (1934), by Tiffany and Tiffany & Ahlstrom, Ohio State University Stone Lab. Contrib. 6:16 (1934) and Ohio Journ. Sci. 31:457 (1931), or by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930); or of *G. rosea* by Snow, Bull. U. S. Fish Comm. 22:392 (1902). I was unable to find plants of *G. lacustris* in the specimen reported by Britton & Smith, Proc. Ind. Acad. Sci. 42:45 (1932).

G. APONINA Kütz. loc. cit. (1836).

Plants blue-green, yellowish, or brownish; gelatinous matrix evident or diffluent externally; protoplasts up to 6 μ broad, blue-green to brownish, homogeneous or granular. Figs. 20 and 21.

Plants growing subaerially are often seen to have narrow or otherwise shriveled protoplasts. *G. aponina* is found on wet rocks and in ponds and lakes. In the plankton the protoplasts are nearly always brilliantly dark blue-green in color; in subaerial masses they are paler, often yellowish or brownish.—No specimens were seen to support the reports of *G. aponina* by Evermann & Clark, Ind. Dept. Conserv. Publ. No. 7, 2:141 (1920), and by Riddle, Ohio Nat. 5:268 (1905); of *G. aponina* var. *aurantiaca* by Snow, Bull. U. S. Fish Comm. 22:392 (1902), and by Smith, Proc. Ind. Acad. Sci. 41:182 (1931); and of *G. aponina* var. *cordiformis* by Tiffany, Ohio State University Stone Lab. Contrib. 6:15, 16 (1934). Only a species of *Botryococcus* was found in the specimen reported as *G. aponina* by McInteer, Castanea 4:28 (1939) and Ohio Journ. Sci. 30:132 (1930). Included here are the specimens upon which are based the reports of *G. aponina* by Palmer, Butler University Bot. Stud. 3:102 (1934), and by Smith, Proc. Ind. Acad. Sci. 41:182 (1931).

Specimens seen: OHIO: HAMILTON COUNTY: reservoir, Eden Park, Cincinnati, *177, 404, 406*, Oct., July (Da, FM), *F. K. Daily*, Aug. 1940 (Da, FM).—KENTUCKY: WOLFE COUNTY: on sandy soil beneath sandstone overhang, Torrent, *Kosanke, F. K. & W. A. Daily 485*, on sandstone overhang, *489, 457, 473, 478*, July 1940 (Da, FM).—INDIANA: STEUBEN COUNTY: Crooked Lake, *Palmer B54*, Sept. 1933 (FM). ELKHART COUNTY: swamp, Goshen, *Smith 205*, Sept. 1929 (FM).

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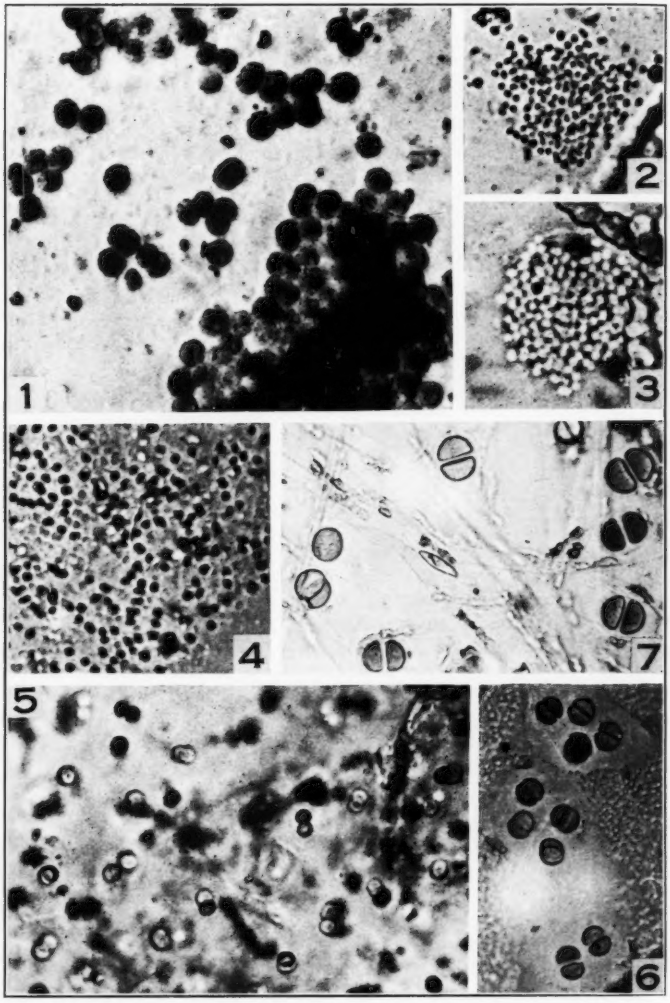

PLATE 1. Fig. 1. *Polycystis aeruginosa* Kütz. Figs. 2 and 3. *Polycystis incerta* Lemm. Fig. 4. *Aphanocapsa Richteriana* Heiron. Fig. 5. *Aphanocapsa Grevillei* (Hass.) Rabenh. Fig. 6. *Chroococcus limneticus* Lemm. Fig 7. *Chroococcus turgidus* (Kütz.) Näg., showing plants from a planktonic habitat.

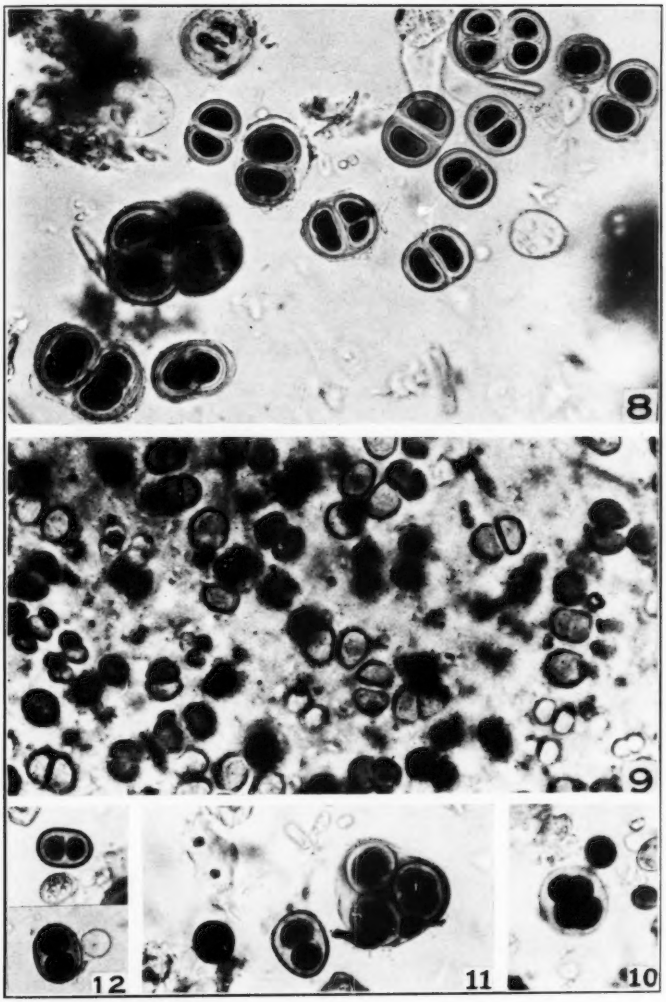

PLATE 2. Fig. 8. *Chroococcus turgidus* (Kütz.) Näg., showing plants from a subaerial habitat. Fig. 9. *Chroococcus rufescens* (Kütz.) Näg. Figs. 10, 11, and 12. *Gloeocapsa magma* (Bréb.) Kütz.

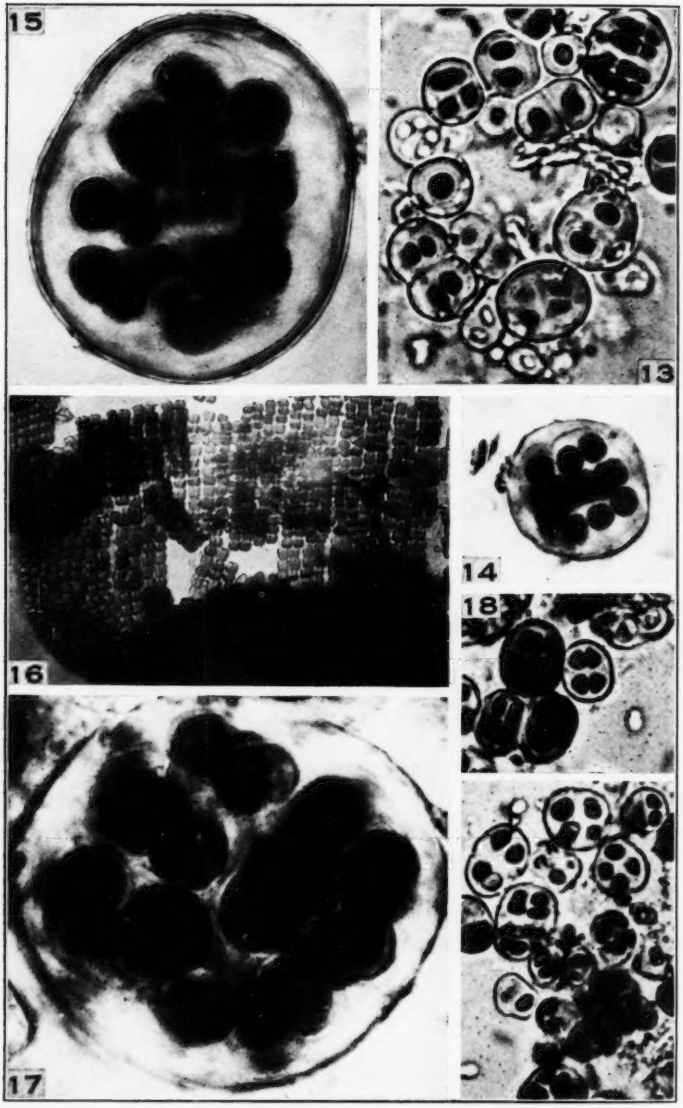

Plate 3. Figs. 13 and 14. *Gloeocapsa nigrescens* Näg. Fig. 15. *Gloeocapsa rupestris* Kütz. Fig. 16. *Merismopoedia convoluta* Bréb. Fig. 17. *Gloeocapsa magma* (Bréb.) Kütz. Fig. 18. *Gloeocapsa aurata* Stizenb.

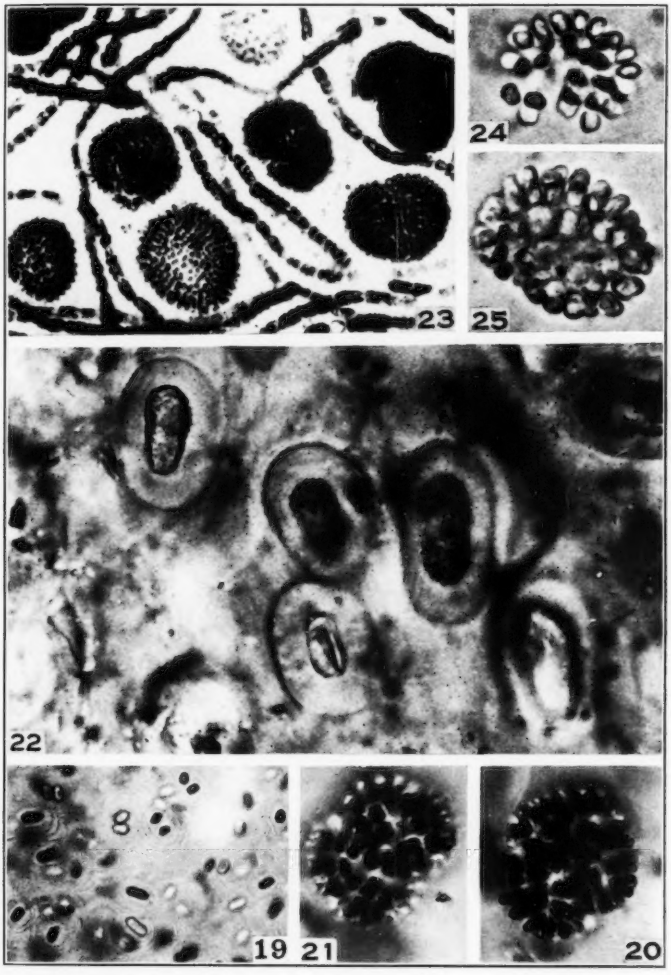

PLATE 4. Fig. 19. *Anacystis rupestris* (Lyngb.) Drouet & Daily. Figs. 20 and 21. *Gomphosphaeria aponina* Kütz. Fig. 22. *Chroothece monococca* (Kütz.) Hansg. Fig. 23. *Coelosphaerium Kuetzingianum* Näg. Figs. 24 and 25. *Coelosphaerium Collinsii* Drouet & Daily.

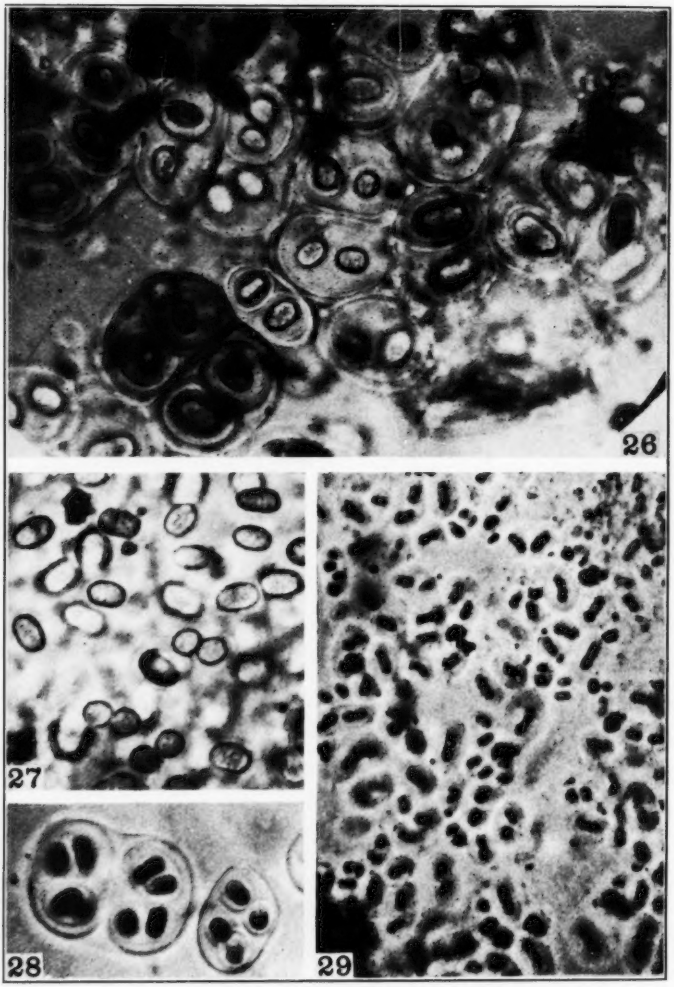

PLATE 5. Fig. 26. *Anacystis rupestris* (Lyngb.) Drouet & Daily. Fig. 27. *Anacystis rupestris* var. *prasina* (A. Br.) Drouet & Daily. Fig. 28. *Anacystis marginata* Menegh. Fig. 29. *Anacystis Peniocystis* (Kütz.) Drouet & Daily.

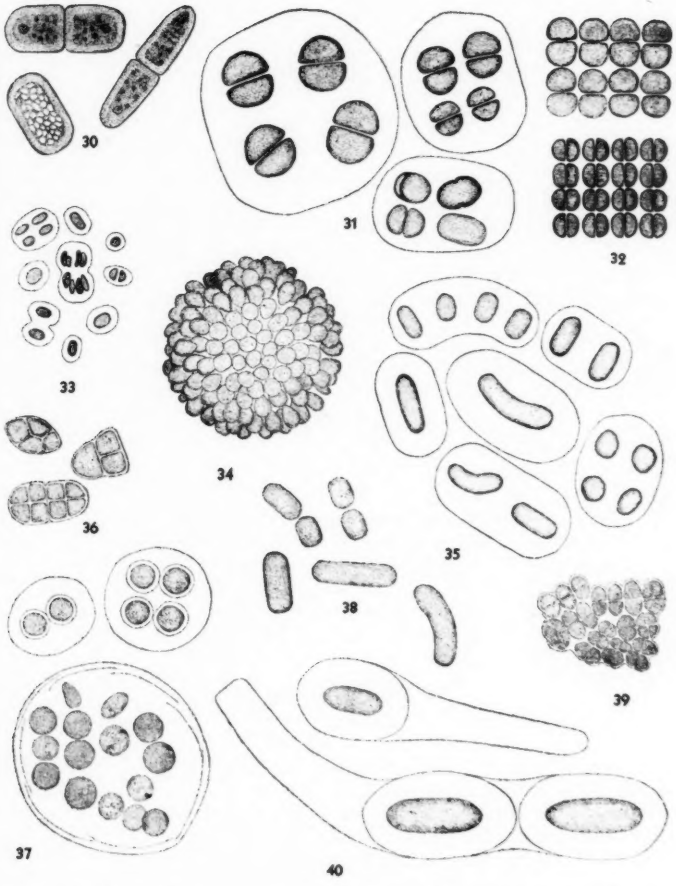

PLATE 6. Fig. 30. *Synechococcus aeruginosus* Näg. Fig. 31. *Chroococcus limneticus* Lemm. Fig. 32. *Merismopoedia glauca* (Ehr.) Kütz. Fig. 33. *Chroothece monococca* (Kütz.) Hansg. Fig. 34. *Coelosphaerium Collinsii* Drouet & Daily. Figs. 35 and 38. *Anacystis Peniocystis* (Kütz.) Drouet & Daily. Fig. 37. *Gloeocapsa nigrescens* Kütz. Figs. 36 and 39. *Pleurocapsa varia* (A. Br.) Drouet & Daily. Fig. 36. Showing small groups of cells pressed apart from the stratum. Fig. 40. *Chroothece monococca* (Kütz.) Hansg., showing stipe-like gelatinous matrix.

The Algae of New England—II.

Additions to the Freshwater Algal Flora of Massachusetts[1]

Gerald W. Prescott and Hannah T. Croasdale

In an earlier paper (10) the authors pointed out that the freshwater algal flora of Massachusetts merited further ecological and taxonomic studies, even though this region has received much attention from collectors since the time of Bailey (1), Wood (15), and other earlier American phycologists. The present study extends the already long list of forms known for Massachusetts and brings together a number of species and forms new to the state, some not having been reported heretofore from North America. Also, a few previously reported species are listed herein if they are little known or if an illustration seems warranted. While many of the species included in this paper are known to occur rather widely, the need for complete distribution data justifies placing them on record for Massachusetts.

It is noteworthy that many of the plants listed here are reported previously only from northern European stations. Their appearance in New England, therefore, contributes evidence of a north temperate distribution for them. Such locality records obviously are necessary toward an understanding of many phytogeographical problems. Most forms, of course, have a wide and very general range, but it is interesting to note, as distribution records are compiled, that many species seem to fall into zonations which are either latitudinal or longitudinal. The significance of such environmental selectivity is that some aquatic cryptogams have more geographical limitations than often is realized by ecologists.

The habitat locality is given for each species in the following list. Material upon which this study is based is deposited in the private collections of the authors.

The authors are grateful for facilities provided by the Marine Biological Laboratory where they were stationed when the material for this paper was collected. The senior author also wishes to acknowledge thankfully a grant in aid from the American Association for the Advancement of Science which facilitated the preparation of an iconograph used in this study.

Taxonomic List

Myxophyceae

Anabaena oscillarioides Bory, Dict. Class. d'Hist. Nat. 1:308. 1822. —Cells spherical or a little longer than broad, arranged in straight or slightly

[1] I. New or noteworthy fresh water algae of Massachusetts. Trans. Amer. Microsc. Soc. **56**(3). 1937.

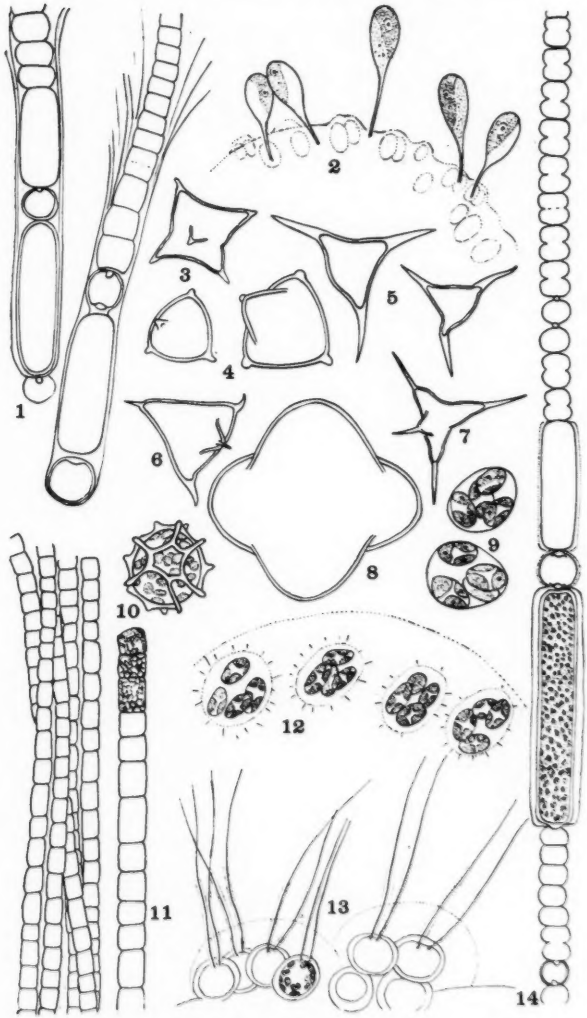

PLATE 1.—1. *Gloeotrichia Pilgeri* Schm. 2. *Stylosphaeridium stipitatum* (Bach.) Geitler & Gimesi. 3. *Tetraëdron regulare* var. *torsum* (Turn.) Brunn. 4. *Tetraëdron regulare* Kuetz. 5. *Tetraëdron trigonum* fa. *gracile* Reinsch. 6. *Tetraëdron regulare* var. *torsum* (Turn.) Brunn. 7. *Tetraëdron regulare* var. *incus* Teiling. 8. *Tetraëdron tumidulum* (Reinsch) Hansg. 9. *Oocystis Borgei* Snow. 10. *Trochiscia erlangensis* Hansg. 11. *Trichodesmium lacustre* Klebahn. 12. *Bohlinia echnida* (Bohlin) Lemm. 13. *Gloeochaete Wittrockiana* Lag. 14. *Anabaena oscillarioides* Bory.

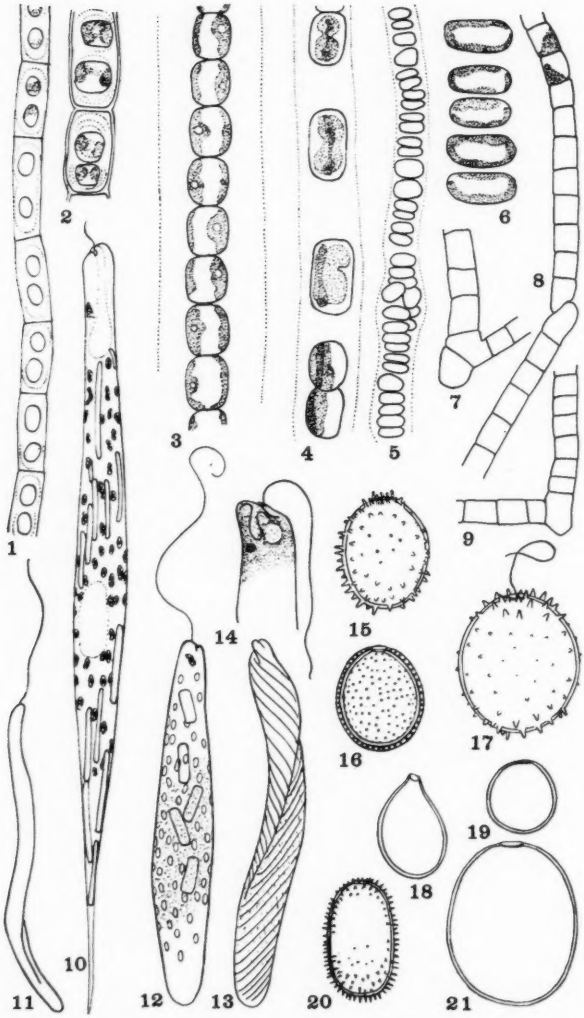

PLATE 2.—1. *Binuclearia tatrana* Wittr. 2. *Binuclearia tatrana* Wittr. 3. *Geminella mutabilis* (Naeg.) Wille. 4. *Geminella interrupta* (Turp.) Lag. 5. *Radiofilum flavescens* G. S. West. 6. *Radiofilum flavescens* G. S. West. 7. *Stichococcus rivularis* (Kuetz.) Hazen. 8. *Stichococcus rivularis* (Kuetz.) Hazen. 9. *Stichococcus rivularis* (Kuetz.)

curved filaments which are not entangled; diameter 7.8 μ, length of cell 7.8-8.3 μ; heterocysts olive or pale blue-green, 8.8-9.2 μ in diameter, 8.8-9.2 μ long; spores adjacent to and on both sides of the heterocysts, 11.5-11.7 μ in diameter, 39-(65)-78.5 μ long. Pl. I, Fig. 14. In a seep and ditch at the bottom of a deep ravine opening into Oyster Pond, Falmouth. July, 1937.

Previously reported from Massachusetts. This plant is of interest because it combines some of the characters of var. *elongata* (Kuetz.) Born. et Flah. and *Anabaena lapponica* Borge. Our specimens are, in general, larger throughout than the dimensions given for *A. oscillarioides*. In shape of cell, and size of gonidia, they are like *A. lapponica;* the diameter of the heterocysts equals that of *A. oscillarioides* var. *elongata* but they are always spherical (not elongated as in that variety). Although we have not had an opportunity to see specimens of *A. lapponica* Borge for comparison, the description and original figures do not seem to separate clearly this plant from some of the expressions of *A. oscillarioides* Bory.

TRICHODESMIUM LACUSTRE Klebahn, Forsch. Biol. Stat. Plön 3:13. 1895. —Cells 4 μ in diameter, 6-8 μ long, forming straight filaments which are gathered together, several to many in a bundle. Cove Pond, Naushon Island. July, 1935. Plate 1, Fig. 11.

The exact position of this plant has often been questioned. It has been suggested that it is an *Oscillatoria*, an *Anabaena*, or possibly a growth phase of *Aphanizomenon*. However, the Trichodesmium-like plant is found repeatedly in New England and in the Mid-west. The senior author has made several collections in which the bundles of filaments are large, the trichomes very long, and with the cells not showing Nostocaceous characters. Hence, we feel that this plant is a freshwater member of the genus Trichodesmium. New record for Massachusetts.

GLOEOTRICHIA PILGERI Schmidle, Hedwigia 40:52, Pl. 14, Figs. 14, 15. 1901.—Cells 9.7-10 μ in diameter, 7-8-9.7 μ long; heterocysts 9.7 μ in diameter, 9.7-10.3 μ long; gonidia 15.6 μ in diameter, 41.9-66.3 μ long; colonies hemispherical of but few filaments with lamellated sheaths, embedded in copious mucilage; heterocysts often two, basal and intercalary between vegetative cells and the gonidia, or between gonidia which occur two or three in a series. Attached to submerged vegetation in cold spring water on Cutty Hunk Island. August, 1937. Plate 1, Fig. 1.

A new record for North America.

Hazen. 10. *Euglena acus* Ehr. 11. *Euglena Ehrenbergii* Klebs, outline of individual in extended position. 12. *Euglena Ehrenbergii* Klebs, showing paramylon bodies. 13. *Euglena Ehrenbergii* Klebs, individual slightly contracted showing spiral striations of the periplast. 14. *Euglena Ehrenbergii* Klebs, detail of anterior portion. 15. *Trachelomonas superba* Swir. fa. 16. *Trachelomonas zorensis* Defl. 17. *Trachelomonas superba* var. *duplex* Defl. 18. *Trachelomonas volzii* var. *pellucida* Playf. 19. *Trachelomonas volvocina* Ehr. 20. *Trachelomonas australica* var. *rectangularis* Defl. 21. *Trachelomonas Dybowskii* Drez.

GLOEOCHAETE WITTROCKIANA Lagerheim, Öfv. Kgl. Sv. Vet.—Akad. Forhandl. 40(2):39. Pl. 1, Figs. 3, 4. 1883.—Cells 12:6 μ in diameter, arranged in hemispherical, gelatinous masses in groups of 4, each cell bearing one or two very long, slender, gelatinous hairs with sheathed bases. Harper Pond, Woods Hole. July, 1939. Pl. 1, Fig. 13.

New record for Massachusetts. This plant is of special interest because of the interpretation of the blue-green chromatophores. Like *Glaucocystis, Nostochinearum* Itz., *Gloeochaete* is regarded as a case of symbiotism in which the host cell is a Tetrasporaceous plant and the endophyte a Myxophycean form.

CHLOROPHYCEAE

STYLOSPHAERIDIUM STIPITATUM (Bach.) Geitler & Gimesi, Arch. f. Protist. 52:609. Fig. C. 1925.—Cells 7.8 μ in diameter, 11.7 μ long without stipe, 35 μ long with stipe, with a single, large, parietal chloroplast and a conspicuous pyrenoid. Oyster Pond, Falmouth. July, 1939. Pl. 1, Fig. 2.

New record for Massachusetts. Whenever this plant was found it was growing attached to colonies of *Botryococcus Braunii* Kuetz., although characteristically it grows on *Coelosphaerium* ssp.

BINUCLEARIA TATRANA Wittrock, Bih. Kgl. Sv. Vet.-Akad. Handl. 12 Afd. 3(1):9. 1886.—Cells 9.7 μ in diameter, 11.7 μ long, walls thick, lamellated. Common in acid ponds on the Cape and Elizabeth Islands. Pl. 2, Figs. 1, 2.

New record for Massachusetts.

GEMINELLA FLAVESCENS (G. S. West) Wille, in Engler & Prantl, Die natürlichen Pflanzenfamilien, Nachträge zum 1. Teil, 2. Abt.: 72. 1911. (*Hormospora minor* Naeg.).—Cells 11 μ in diameter, 7-8.5 μ long, elliptical, compactly arranged in narrow (usually) gelatinous tubes. Pond near the shore road from Woods Hole to Falmouth. June, 1932. Pl. 2, Figs. 5, 6.

New record for Massachusetts.

GEMINELLA INTERRUPTA (Turp.) Lagerheim, Öfv. af Köngl. Vet.-Akad. Forhandl. 40(2):68, Pl. 1, Figs. 30-35. 1883.—Cells 15.6 μ in diameter, 27.3 μ long; width of filament including sheath 26 μ; chloroplast a parietal and folded plate, usually with two pyrenoids. Widely distributed on the Elizabeth Islands and Cape Cod. Pl. 2, Fig. 4.

New record for Massachusetts.

GEMINELLA MUTABILIS (Naeg.) Wille, in Engler & Prantl, Die natürlichen Pflanzenfamilien, Nachträge zum 1. Teil, 2. Abt.: 72. 1911. (*Hormospora mutabilis* Naeg.)—Cells 15.6 μ in diameter, 19.5 μ long; width of filament including sheath 39 μ; chloroplast one, parietal and usually very dense. In Stone Wall Pond, Nonamesset Island; ponds on Pasque Island. July, 1932. Pl. 2, Fig. 3.

STICHOCOCCUS RIVULARIS (Kuetz.) Hazen, Mem. Torr. Bot. Club 11: 166, Pl. 22, Figs. 10-13. 1902. (*Hormidium rivulare* Kuetz.)—Filaments long, frequently with irregular false branches; cells 10 μ in diameter, 10-13 μ long;

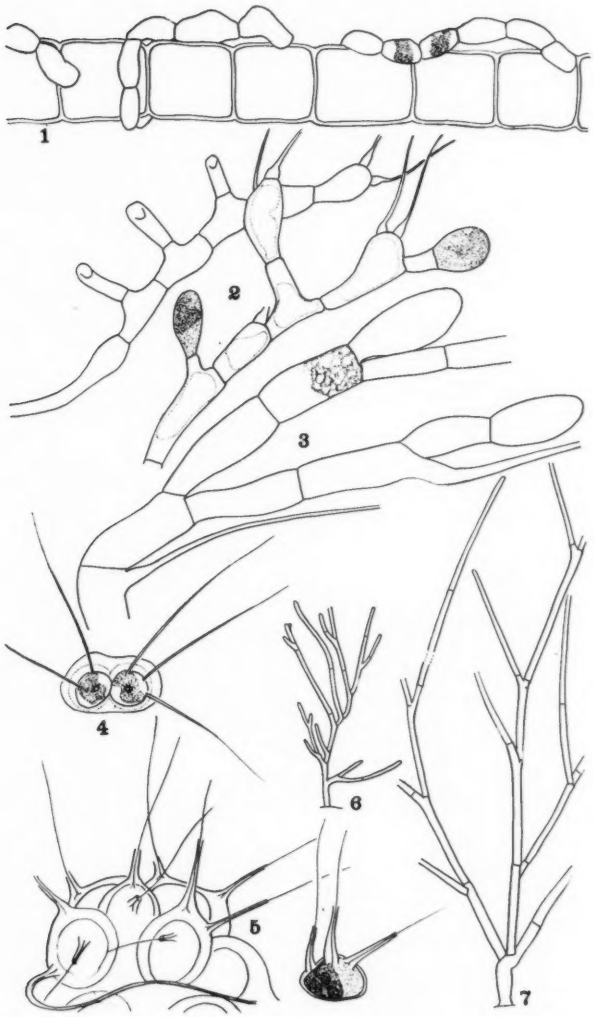

PLATE 3.—1. *Herposteiron vermiculoides* (Wolle) Collins. 2. *Chaetonema irregulare* Nowak. 3. *Fridaea torrenticola* Schm. 4. *Oligochaetopohra simplex* G. S. West. 5. *Conochaete comosa* Klebahn. 6. *Microthamnion strictissimum* Rab. 7. *Microthamnion strictissimum* Rab.

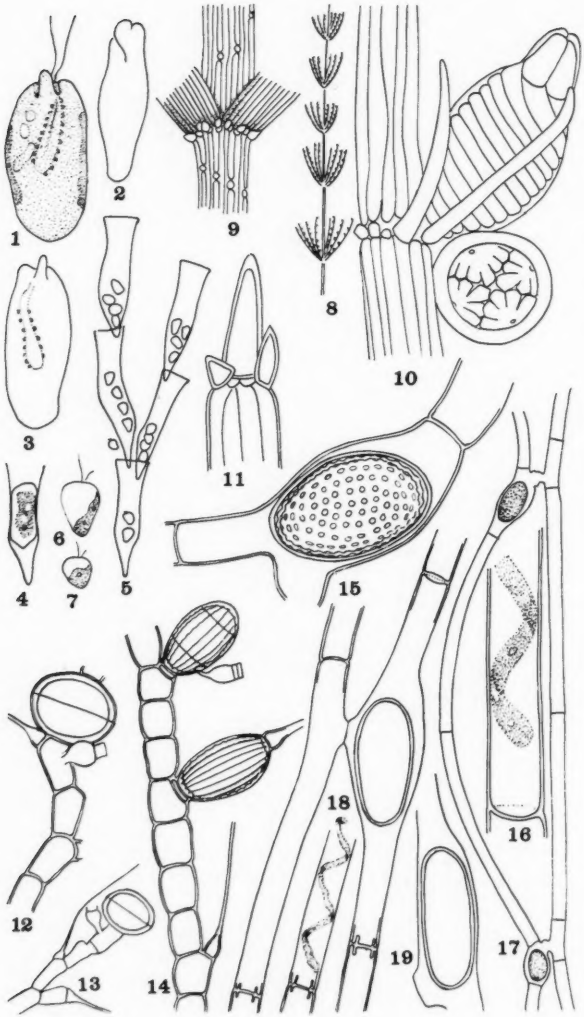

PLATE 4. 1. *Cryptochrysis comutata* Pascher, face view. 2. *Cryptochrysis comutata* Pascher, side view. 3. *Cryptochrysis comutata* Pascher, reverse of view in Fig. 1. 4. *Dinobryon sertularia* Ehr., single cell. 5. *Dinobryon sertularia* Ehr., a few cells from dendroid colony. 6-7. *Dinobryon sertularia* Ehr., zoospores. 8. *Chara delicatula* Ag.,

chloroplast a broad, parietal disc covering about one-third of the cell wall. Cranberry Pond, Bourne. August, 1936. Pl. 2, Figs. 7-9.

New record for Massachusetts.

HERPOSTEIRON VERMICULOIDES (Wolle) Collins, The Green Algae of North America, p. 311. 1909. (*Aphanochaete vermiculoides* Wolle).—Cells 4-7 μ in diameter, 8-12 μ long, cylindrical or barrel-shaped, sometimes with the sides next to the substrate flattened and the free wall irregularly arched; creeping on other algae with the filament making contact at infrequent intervals. Uncommon; usually in acid habitats. Pond on Nonamesset Island. July, 1932. Pl. 3, Fig. 1.

New record for Massachusetts.

CHAETONEMA IRREGULARE Nowak., in Cohn, Beitr. z. Biol. Pflanzen 2(1):75. 1877. This plant has been reported previously from Massachusetts but seems to be relatively rare. Our specimens were found growing in the mucilage of *Chaetophora incrassata* (Huds.) Hazen where it can be overlooked very easily. Mill Pond, Hyannis. July, 1939. Pl. 3, Fig. 2.

CONOCHAETE COMOSA Klebahn, Pringsheim's Jahr. f. wissensch. Botanik 25:317, Pl. 14, Figs. 17, 18. 1893.—Cells 10-11.7 μ in diameter, with 2-4 μ long, tapering hairs which have tubular sheathed bases, occurring in loose clusters of 4 to 12 on large filamentous algae or on the tissues of higher plants. In shallow water of a backwash and a seep along the shore of Sheep Pond, Cutty Hunk Island. July, 1937. Pl. 3, Fig. 5.

New record for North America.

MICROTHAMNION STRICTISSIMUM Rabenhorst, Algen Sachs. No. 829, 1859; Krypt. Flora Sachs. 1:266, Fig. on p. 236. 1863.—Forming minute arbuscular tufts on submerged aquatics; habit of branching showing a distinct main axis; cells 3.5 μ in diameter, 36-38 μ long. In squeezings from Sphagnum in the marginal water of John Pond, Mashpee. July, 1939. Pl. 3, Figs. 6, 7.

This species is less frequently seen than *M. Kuetzingianum* Naeg. and appears to have a much more restricted distribution. The var. *macrosystis* Schm. of *M. strictissimum* Rab. has been reported previously from Massachusetts, but not figured.

OLIGOCHAETOPHORA SIMPLEX G. S. West, Jour. Bot. 49:89. 1911.—Cells in groups of 2-6 on submerged aquatics or large filamentous algae; each

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habit of portion of plant. 9. *Chara delicatula* Ag., detail of node showing stipulodes. 10. *Chara delicatula* Ag., sex organs. 11. *Chara delicatula* Ag., detail of apex of branchlet. 12. *Bulbochaete minuta* W. & G. S. West, oogonium showing smooth oospore wall. 13. *Bulbochaete minuta* W. & G. S. West, habit of branching. 14. *Bulbochaete varians* Wittr. 15. *Spirogyra collinsii* (Lewis) Printz var. *minor* var. nov., zygospore. 16. *Spirogyra collinsii* (Lewis) Printz var. *minor*, chloroplast. 17. *Spirogyra collinsii* (Lewis) Printz, var. *minor*, conjugation habit. 18. *Spirogyra cylindrica* Czurda, chloroplast. 19. *Spirogyra cylindrica* Czurda, zygospore.

cell bearing 2-4 long, tapering, unsheathed hairs; cells 11 μ in diameter. In pond on Pasque Island. July, 1936. Pl. 3, Fig. 4.

New record for North America.

FRIDAEA TORRENTICOLA Schmidle, Allg. Bot. Zeit. **11**(4):64. 1905.—Filaments branching alternately, or irreguarly; branches short, sometimes one-celled, arising from the distal ends of the cells, long, hollow setae developing occasionally from the lateral walls at the distal end; terminal cells oval or cylindrical with broadly rounding apices; cells in lower portion of the filament colorless; cells in the upper or distal region with a single massive, parietal chloroplast; cells 6.2-8 μ in diameter, 2-10 times longer than wide. Wood Pond, Woods Hole. August, 1932. Pl. 3, Fig. 3.

Previously reported in the United States from California.

BOHLINIA ECHNIDA (Bohlin) Lemmermann, Forsch. Biol. Stat. Plön 7: 120. 1899. (*Oocystis echnida* Bohlin).—Cells oval, 1½-2 times longer than wide, embedded in a gelatinous matrix, solitary or in groups of 4 within old mother cell walls which bear a few, short setae; chloroplasts 1-4, parietal; cells 4.3 μ in diameter, 9.5 μ long. Clubhouse Pond, Cuttyhunk Island. August, 1938. Pl. 1, Fig. 12.

New record for Massachusetts; previously reported from California.

OOCYSTIS BORGEI Snow, Bull. U. S. Fish. Comm. **22**:379, Pl. 2, Figs. VII-1—VII-5. 1903.—Cells ellipsoid to oval, in groups of 4 within old mother cell walls; chloroplasts 1-4, parietal; cells 9-11 μ in diameter, 12-16 μ long. Generally distributed in ponds on Cape Cod and the Elizabeth Islands. Pl. 1, Fig. 9.

New record for Massachusetts.

TETRAEDRON REGULARE Kuetzing, Phycologia germanica, p. 129. 1845.—Cells 4-lobed (tetragonal), the lobes tipped with a single blunt spine, 15-20 μ in diameter. Fresh Pond, Nobska Point, Woods Hole. July, 1933. Pl. 1, Fig. 4.

The var. *longispinum* (Reinsch) De Toni has been reported previously from Massachusetts.

TETRAEDRON REGULARE var. INCUS Teiling, Svensk Bot. Tidskrift, 6:277, Fig. 12. 1912.—Cells 4-angled, the angles produced and the sides concave between the angles, each angle furnished with a long, slender spine; 33 μ in diameter with spines, 18.1 μ without spines. Pond near Falmouth. July, 1933. Pl. 1, Fig. 7.

New record for Massachusetts.

TETRAEDRON REGULARE var. TORSUM (Turn.) Brunnthaler, in Pascher's Süsswasserflora Deutsch. Österr. u. d. Schweiz 5(2):150, Fig. 169. 1915.—Cells 4- or 5-angled, margins concave between the angles which are tipped with a short, sharp spine; 27 μ in diameter. Wheeler Pond, Falmouth. July, 1933. Pl. 1, Figs. 3, 6.

New record for Massachusetts.

TETRAEDRON TRIGONUM fa. GRACILE Reinsch, Die Algenfl. d. mitt. Th.

PLATE 5. 1. *Oedogonium paucocostatum* Trans. var. *seriacea* n. var., series of oogonia. 2. *Oedogonium paucocostatum* Trans. var. *seriacea*, oospore. 3. *Oedogonium paucocostatum* Trans. var. *seriacea*, antheridia. 4. *Oedogonium crispum* (Hass.) Wittr., filament and holdfast. 5. *Oedogonium crispum* (Hass.) Wittr., oospore and antheridium. 6. *Oedogonium oelandicum* Wittr. 7. *Oedogonium inversum* Wittr. 8. *Oedogonium megaporum* Wittr., habit. 9. *Oedogonium megaporum* Wittr., detail of oogonium and oospore.

v. Franken, p. 75, Pl. III, Figs. 1a-1b. 1867.—Cells 3-angled, angles produced into stout spines, margins of cell concave or convex between the angles; 35 μ in diameter with spines, 10-13 μ without spines. Pond in Hyannis. July, 1934. Pl. 1, Fig. 5.

New record for Massachusetts.

TETRAEDRON TUMIDULUM (Reinsch) Hansgirg, Hedwigia **28**:18. 1889. —Cells 4-angled, the lobes broadly rounded, 62.4 μ in diameter. Generally distributed. Pl. 1, Fig. 8.

New record for Massachusetts.

TROCHISCIA ERLANGENSIS Hansgirg, Hedwigia **27**:129. 1888.—Cell wall with reticulate thickenings which form a few blunt ridges or projections at the margin; chloroplasts numerous, disc-like; 22 μ in diameter. Deep Pond, Mashpee. June, 1933. Pl. 1, Fig. 10.

New record for North America.

BULBOCHAETE MINUTA W. & G. S. West, Trans. Linn. Soc. London, (Botany) **6(3)**:126, Pl. 17, Fig. 10. 1902—Vegetative cells 11-12 μ in diameter, 16-20 μ long; oogonia 31-33 μ in diameter, 23-27 μ long; oospore 24-27 μ in diameter, 18-22 μ long; androsporangium 9 μ in diameter, 66 μ long; dwarf male 7 μ in diameter, 20 μ long. Pond in Falmouth. July, 1935. Pl. 4, Figs. 12, 13.

Widely distributed.

BULBOCHAETE VARIANS Wittrock Öfver. af Kongl. Vet.-Akad.Forhandl. **1870(3)**: 143. 1870.—Vegetative cell 16.5 μ in diameter, 22 μ long; oogonium 25.4 μ in diameter, 42.9 μ long; oospore 25μ in diameter, 37.5 μ long, the wall longitudinally ribbed, the ribs serrate; dwarf male 15 μ in diameter; antheridial cell 9 μ in diameter, 6 μ long Wood Pond, Woods Hole. June, 1933. Pl. 4, Fig. 14.

Previously reported from Florida, Massachusetts, and Oklahoma.

Oedogonium paucocostatum Trans. var. **seriaceum** var. nov.—Smaller than the typical form; oogonia in series of 2-6, ellipsoid to subcylindric; oospores ellipsoid or oblong. Vegetative cells 13.6-15.5 μ in diameter, 54-78 μ long; oogonium 34-37 μ wide, 50.7-74 μ long; oospores 32.1-35 μ in diameter, 44.8-52 μ long; antheridial cells 11.7 μ in diameter, 4-5.8 μ long. John Pond, Mashpee. Aug., 1938. Pl. 5, Figs. 1-3.

Minor quam forma typica; oogoniis 2-6 seriatim dispositis, ellipsoideis vel subcylindricis; oosporis ellipsoideis vel oblongis. Cellulis vegetativis 13.6-15.5 μ crass., 54-78 μ long.; 34-37 μ crass., 50.7-74 μ long., oosp. 32.1 μ crass., 44.8-52 μ long.; cell. antherid. 11.7 μ crass., 4-5.8 μ long.

This plant is remindful of *Oe. crenulatocostatum* var. *cylindricum* (Hirn) Tiffany in the arrangement of the oogonia and in the shape of the oospores. However, the Massachusetts plant is operculate, while the former is poriferous and its oospore has ribs which are crenulate. Because of its size, our plant is assigned to *Oe. paucocostatum*. Trans. but other than that it might well be

considered a variety of *Oe. paucostriatum* Tiffany, which is apparently separated from the former species on the basis of size alone.

OEDOGONIUM CRISPUM (Hass.) Wittrock, Nova Acta Regiae Soc. Sci. Upsala 9(3):10. 1874.—Vegetative cell 14.5-15.6 μ in diameter, 56-66.3 μ long; oogonium 43.9 μ in diameter, 43.9-52 μ long, opening by a superior operculum; oospore globose, 39 μ in diameter. John Pond, Mashpee. Aug., 1937. Pl. 5, Figs. 4, 5.

The var. *gracilescens* Wittr. has been reported previously from Massachusetts.

OEDOGONIUM INVERSUM Wittrock, in Nordstedt & Wittrock, Öfver. af Kongl. Vet.-Akad. Forhandl. 1876(6):47, Pl. 13, Figs. 22-24. 1876.—Vegetative cells 12.5-13.6 μ in diameter, 40-80 μ long; oogonium globose, 33.5 μ in diameter, 33-37 μ long; oospore globose, filling the oogonium, 30 μ in diameter. Pond on Nonamesset Island. Aug., 1937. Coll. C. M. Palmer. Pl. 5, Fig. 7.

New record for Massachusetts.

OEDOGONIUM MEGAPORUM Wittrock, Botaniska Notiser 1872(1):3, Pl. 1, Figs. 5, 6. 1872. (Fa.)—Vegetative cell 18 μ in diameter, 72-90 μ long; oogonium 50.4 μ in diameter, 39-40 μ long; oospore 30-31 μ in diameter, 32-33 μ long. Lake in Hyannis. Aug., 1937. Pl. 5, Figs. 8, 9.

New record for Massachusetts. The oogonia and oospores of our plants are larger by 10 μ in both diameter and length. Not enough specimens were seen to justify describing this as a distinct variety, but we believe this to be a new form of *Oe. megaporum*.

OEDOGONIUM OELANDICUM Wittrock, Nova Regiae Soc. Sci. Upsala 9(3):17. 1874.—Somewhat larger than the typical form. Vegetative cell 16.2-18 μ in diameter, 55-75 μ long; oogonium 47 μ in diameter, 41-55 μ long; oospore 41 μ in diameter, 37 μ long. On Sphagnum at edge of pond in Hyannis. July, 1939. Pl. 5, Fig. 6.

New record for Massachusetts.

Spirogyra collinsii (Lewis) Printz var. **minor** var. nov.—Smaller than the typical plant; vegetative cells 13-14 μ in diameter, 115-140 μ long; zygote 29 μ in diameter, 39-40 μ long; sporangial cell increased to 33 μ; conjugation scalariform. Pond in Falmouth. July, 1933. Pl. 4, Figs. 15-17.

Minor quam planta typica; cellulis vegetativis 13-14 μ latis, 115-140 μ longis; zygotis 29 μ latis, 39-42 μ longis; cellulis fructiferis diam. usque ad 35 μ inflatis; conjugatione scalariformi.

SPIROGYRA CYLINDRICA Czurda, in Pascher's Süsswasserflora Mitteleuropas, 2nd ed., 9:150, Fig. 148. 1932.—Cells 12-15 times their diameter in length; chloroplast one, loosely spiralled; vegetative cell 16.5 μ in diameter, 181-198 μ long; zygospores ellipsoid 23.2-26.4 μ in diameter, 52.8-62.9 μ long. Pond on Pasque Island. July, 1933. Pl. 4, Figs. 18, 19.

New record for North America.

EUGLENOPHYCEAE

EUGLENIA ACUS Ehrenberg, Infus. als vollkommene Organismen, p. 112, Pl. 7, Fig. 15. 1838.— Paramylon bodies numerous, long rods; cell 11.7 μ in diameter, 273 μ long. With other species of *Euglena* forming a film on the surface of a brackish pond on Nonamesset Island. June, 1936. Pl. 2, Fig. 10.

New record for Massachusetts.

EUGLENA EHRENBERGII Klebs, Untersuch. bot. Inst. Tübingen 1:304. 1883.—Anterior end broad and truncated, canal and gullet very conspicuous; 19.5 μ in diameter, 195 μ long. In a film on surface of brackish water, Nonamesset Island. June, 1936. Pl. 2, Figs. 11-14.

New record for Massachusetts.

TRACHELOMONAS AUSTRALICA (Playf.) Deflandre var. RECTANGULARIS Deflandre, Monographie du genre Trachelomonas Ehr., p. 83, Pl. 4, Fig. 50. 1926.—Test oblong to sub-cylindric, slightly truncated at the ends; wall with evenly distributed short spines; test 16 μ in diameter, 23.2 μ long. Pond in Falmouth. July, 1933. Pl. 2, Fig. 20.

New record for North America.

TRACHELOMONAS DYBOWSKII Drezepolski, Roz. i Wiad. z Mus. im. Dzieduszyckich, Lwow, VII-VIII: 15, Pl. 1, Fig. 10. 1923.—Test oval, wall smooth, ashy-yellow, 26.4 μ in diameter, 33 μ long. Pond on Pasque Island. July, 1933. Pl. 2, Fig. 21.

New record for North America. Our specimens are larger than usually described for this species.

TRACHELOMONAS SUPERBA Swir. emend. Deflandre, Monographie du genre Trachelomonas Ehr., p. 85, Pl. 4, Figs. 264-269. 1926.—Test oval, spines short and scattered, 35 μ in diameter, 46 μ long. Pond in Falmouth. July, 1933. Pl. 2, Fig. 15.

New record for Massachusetts.

TRACHELOMONAS SUPERBA Swir. emend. Deflandre var. DUPLEX Deflandre, Monographie du genre Trachelomonas Ehr., p. 85, Pl. 4, Fig. 270. 1926.—Test oval, beset with spines which are a little longer and stouter, both posterior and anterior; 30 μ in diameter, 40 μ long. Gifford Swamp, Falmouth. July 1933. Pl. 2, Fig. 17.

New record for North America.

TRACHELOMONAS VOLVOCINA Ehrenberg, Infus. als volkommene Organismen, p. 48, Pl. 2, Fig. 29. 1938.—Test oval, coarsely punctate and scrobiculate; 16.5 μ in diameter, 19.8 μ long. Pond on Pasque Island. July, 1933. Pl. 2, Fig. 19.

New record for Massachusetts.

TRACHELOMONAS VOLZII var. PELLUCIDA Playfair, Proc. Linn. Soc. New South Wales, 2nd ser., 40:14. Pl. 2, Fig. 1. 1915.—Test oval, extended into a

neck which is 5 μ wide at the flagellum aperture; 27.5 μ in diameter, 42.5 μ long. Fresh Pond, Nobska Point, Woods Hole. June, 1932. Pl. 2, Fig. 18.

New record for North America.

TRACHELOMONAS ZORENSIS Deflandre, Monographie du genre Trachelomonas Ehr., p. 92, Pl. 7, Figs. 391-395. 1926.—Tests oval, 16.5 μ in diameter, 19.8 μ long; shell coarsely punctate. Pond on Pasque Island. July, 1933. Pl. 2, Fig. 16.

New record for North America.

CRYPTOPHYCEAE

CRYPTOCHRYSIS COMUTATA Pascher, Ber. d. d. Bot. Ges. 29:190, Fig. 1. 1911.—Cells broadly pyriform and flattened, widest near the anterior end; longitudinal furrow and trichocysts very conspicuous, the latter forming a double row along the margins of the furrow; 19.5 μ wide, 50 μ long. Pond in Falmouth. July, 1935. Pl. 4, Figs. 1-3.

New record for North America.

CHRYSOPHYCEAE

DINOBRYON SERTULARIA Ehrenberg, Abh. d. K. Ak. d. Wiss. Berlin 1883:280. 1885.—Envelope cylindrical with campanulate openings, individuals grouped in much-branched colonies; cells 11-13 μ in diameter, 30-35 μ long. Pond in Bourne. Aug., 1935. Pl. 4, Figs. 4-7.

Widely distributed. Living material was observed in which zoospore formation and discharge was taking place. The zoospores were oval to pyriform and ciliated with the characteristic pair of cilia, one long and one short. They were produced 4 within an envelope, usually. Upon leaving the parent cell they swam at first with a jerky and spiral motion but soon became sluggish and quiescent.

CHARACEAE

CHARA DELICATULA Ågardh, Syst. Alg., p. 130. 1824.—Plants monoecious; cortex triplostichous, the primary cortical cells wider than the secondary. Ponds on the Elizabeth Islands. Pl. 4, Figs. 8-11.

Previously reported from Indiana and Massachusetts, but not figured.

ALBION COLLEGE,
ALBION, MICH.
AND
DARTMOUTH COLLEGE,
HANOVER, N. H.

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Resupinate Pore Fungi in Oregon

Wm. Bridge Cooke

The genus *Poria* was first used, in the sense now current, by Persoon, in his *Dispositio methodica fungorum* of 1794. Later he treated it as a subgenus, in the *Synopsis* (41) under *Boletus,* and in the *Mycologia europaea* (42) under *Polyporus*. It was first validly published by S. F. Gray (22) in 1821, shortly after Fries (21) had commenced the publication of his classic *Systema mycologicum*. Gray used the name for seven species of light-colored resupinate polypores. Fries had used the generic name *Polyporus* for all fungi now included in *Polyporus, Fomes,* and *Poria;* he never had a group of generic rank for resupinate species of polypores. In 1886 M. C. Cooke (18) published his emended form of the genus *Poria*. Karsten had previously used the name for a group of light-colored resupinate polypores, following the Gray interpretation. Whereas Karsten's treatment of the genus excluded species which changed color when bruised or when dry, as well as those with dark context, Cooke included in it all resupinate pore-bearing fungi. It is in the sense of Cooke that the genus is commonly used today. Since *Poria* was first validly used by Gray, however, it must be attributed to him.

As M. C. Cooke emended *Poria,* the genus includes all pore fungi with a resupinate habit of growth. This, to the writer, is still a much too inclusive group to retain in one genus. As Donk (20) has pointed out, *Poria* as at present used is a form genus. When a species can be proven to have at times a reflexed pileus, that species may more naturally be transferred to the genus in which that type of pileus, with its accompanying hymenophore, belongs. Bourdot and Galzin (11), followed by Donk (20), have divided the genus into a number of subgenera in which the morphology is sometimes recognized in the subgeneric name.

Poria, in the sense in which the genus is used today by Baxter (2-10), Overholts (35-39), Lloyd (26), in part by Murrill (28-34), by the present writer, and by other American writers, as well as by many, if not most, European writers, is an artificial genus, polyphyletic in nature, which must sooner or later be arranged in a more natural system. However, this new arrangement cannot be made in a satisfactory way until the different units in related and similarly polyphyletic genera such as *Corticium, Polyporus, Fomes,* and others are better understood.

The morphological characters involved in studies of the more primitive, as well as more advanced, members of the series, are those of the basidia, spores, and hyphae with their clamp connections. Among Oregon species, *Poria candidissima* best illustrates this point. While the hymenial surface presents the porose character which places it in this genus, the hymenial elements, which here include only the basidia, the basidiospores and the ampulla-bearing hyphae, clearly place the species with that group of fungi

related to the Patouillardian genus *Cristella*. This genus contains species elsewhere referred to *Corticium* and *Clavaria* and to avoid confusion it may be best not to make a new combination at this time. However, studies by M. A. Donk, D. P. Rogers, and others, in line with the publications of Patouillard (40), Bourdot and Galzin (11), and others, are steadily increasing our knowledge of these more primitive forms.

The majority of species of *Poria*, having no outstanding characteristics, fall into a generalized group which may be called *Poria proper*, in contrast to the *Corticioid Porias*, one of which was discussed above, and the *Hymenochaetoid Porias* to be discussed shortly. In *Poria proper*, or sensu stricto, are species which appear related to *Merulius, Fomes, Polyporus, Trametes* and other genera, particularly generic segregates of the two larger genera of polypores *(Fomes* and *Polyporus)*. This group includes important slash-rot fungi and forest pathogens and is being intensively studied in the field and laboratory by Dr. D. V. Baxter (2-10). It is possible that most of the species may be placed in one or another of the recognized genera of pore fungi. However, unless one or another of these species is found in a pileate condition, this relationship will have to be based on purely microscopic characters of the hymenium and trama, characters which throughout the higher *Homobasidiomycetes* are notoriously uniform. Comparative studies of the species in culture, a phase of the problem not yet studied by the writer, may also assist in relating resupinate with pileate species. Thus we will probably always have species which can be classed only as *Poria*.

The third general group of *Poriae*, the *Hymenochaetoid Porias*, is easily distinguishable from the others by its brown context, the presence in the hymenium of brown subulate setae (which may, in some species, as Donk (20) has pointed out, be lost through simplification), and the presence of thelephoric acid which in KOH turns a mount of a specimen black and opaque under the microscope. This group is possibly derived from *Hymenochaete*, which it resembles in all characters except the presence of pores or tubes. The brown *Porias* have been divided by Murrill into several genera. As pointed out in an earlier paper (18a) some of these genera are invalid, or synonymous with others. For instance, *Poria ferruginosa* was made the type of a genus in which one of the essential characters was the annual habit. This genus, as defined on this basis, is not distinct since its contrasting genus, having similar spores, is perennial, and since most western specimens of *ferruginosa* are perennial (thick and stratified) rather than annual (thin and unstratified) like eastern specimens. In some perennial specimens of *Poria ferruginosa* a pileus occurs as well formed as the pilei which are found in specimens of *Fomes igniarius* occurring on apple trees in the east. Thus this species may be transferred to a perennial pileate genus such as *Fomes*, or a segregate of it.

At least three of the 39 species to be mentioned are of economic importance (12, 23). *Poria incrassata* is one of the important dry rots in construction timber and houses. Through elongated rhizomorphs it can maintain contact with water supplies located great distances from the region of activity

of the fungus. *Poria Weirii* causes a yellow ring rot in Western Red Cedar *(Thuja plicata.)*. The fungus rarely fruits and specimens are not common in Oregon herbaria. The rot is usually confined to the butt and lower part of the trunk. It is the most serious disease of its host, causing loss of sound heart wood, wind fall, and wind breakage. *Poria humilis* has been collected in a lawn and in an alfalfa field where, in both cases, it was reported as doing damage. This species probably belongs to the group of fungi which cause harmful smothering rather than serious penetration of host tissues. Outbreaks are not often reported. Other listed species may cause more or less important slash rots.

Workable material of the listed species was collected in the fall between October and December. Collections made at other seasons usually proved to be old or otherwise sterile specimens. This observation may indicate a definite seasonal activity on the part of the fungus which is correlated with the opening and first half of the rainy (or winter) season, or merely a seasonal fruiting habit.

In studying specimens in the laboratory the following techniques were employed (27): If the specimens were thick enough sections were cut from dry material with a razor blade, both longitudinal and cross sections being used. In case the specimen was thin a bit was scraped off with a needle. Sections or scraped flakes were placed in a drop of 95% alcohol on a slide. This was allowed to penetrate the specimen, then partially dry. A drop of 1% aqueous phloxine was added to the nearly dry specimen, then a drop of 5% KOH. The potassium hydroxide inflates the material to its approximate normal size. In *Hymenochaetoid Porias* KOH makes specimens opaque because of its reaction with their thelephoric acid content. Because of this a modified Amann's solution was used in studying these specimens. In this case lactic acid is the inflationary medium. Cotton blue was used with it as the stain.

There follow brief notes on the structure and habit of 39 Oregonian resupinate polypores studied. A key to these species precedes the more descriptive discussions.

The problem of the resupinate species of polypores growing in Oregon was undertaken as a Master of Science thesis project at Oregon State College between 1937 and 1939. In that region, the group, most of whose species fall in the genus *Poria* of the *Polyporaceae*, was poorly known and not well represented in the Oregon State College mycological herbarium. The writer's interest in the problem was aroused by Dr. Donald P. Rogers of whose criticisms and suggestions throughout the study he is deeply appreciative. Several hundred collections of 39 species were studied. The writer, Dr. Rogers, and Maxwell Doty, in addition to a number of other collectors, supplied this material.

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1. PORIA CANDIDISSIMA (Schw.) M. C. Cooke

Annual, thin, white, cobwebby, then cottony; *tubes* white becoming cream-color, irpiciform or porose; *pores* 1-4 per mm., 2-3 mm. long, dissepiments 200-300 μ thick; white to pale cream color when dry; *context* composed of loosely interwoven hyaline hyphae of which the smaller are encrusted; *hyphae* thin-walled, measuring (3-)4.5-5.6(-8.4) μ in diameter; *basidia* ovate, fasciculate, 4.5-8.5 μ in diameter; sterigmata 4, 3.5 μ long; *spores* ovate, asperulate, hyaline, with 1 oil drop, 4-4.5 x 3.5-4 μ; *clamp connections* abundant, found at each septum, at least half as wide as the hyphae bearing them; *ampullae* present, nearly twice the width of the hypha which bears them.

On rotten wood of *Pseudotsuga taxifolia, Picea sitchensis, Alnus oregana, Acer macrophyllum, Quercus Garryana,* etc., in Benton, Douglas, Marion, Lincoln and Linn Counties.

2. PORIA SITCHENSIS Baxter

Effused over the under side of fallen logs, 5-25 x 5-10 cm., 1-5 mm. thick; *margins* broad, becoming resinous and brownish, sterile portion 1-10 mm. broad, not separable; *tubes* up to 5 mm. long, white, becoming stuffed; *pores* white to cream-color, 2-4 per mm., dissepiments 150-300 μ wide; *hyphae* hyaline, 2.5-3 μ in diameter, with narrow lumen; trametoid; *basidia* club-shaped, 21 x 4-6 μ, with 4 sterigmata 2 μ long; *spores* cylindric or slightly allantoid, 4.2-4.9 x 1.5-2.2 μ with 1-2 oil drops; *hyphal pegs* forming the stuffing in the older portions of the tubes; cystidia and clamp connections not seen.

On rotten logs of *Pseudotsuga taxifolia* and *Picea sitchensis,* in Benton and Lincoln Counties.

3. TRAMETES STUPPEA Berk.

An old, completely sterile, specimen has been seen and referred to this species. It is completely resupinate; *pores* angular to more or less hexagonal, more or less regular, or more or less daedaleoid, 1-2 per mm., mostly 1 mm. in diameter.

On rotten conifer, in Coos County.

4. TRAMETES HETEROMORPHA (Fr.) Bres. ex Neuman

Fructification annual, effused up to 12 x 5 cm.; *margin* definite, soon porose, white then clay-colored, inseparable; *tubes* 0.5-12 mm. long; *pores* white to cream when young, clay-color in age, round to angular, 1-2 mm. in diameter; *hyphae* up to 4 μ in diameter; *basidia* club-shaped, 16-20 x 5.5-6 μ, with short sterigmata; *spores* cylindric or subfusiform, 13.0-14.5 x 3.5-4.5 μ, hyaline, without oil drops; cystidia, hyphal pegs and clamp connections not seen.

On *Populus trichocarpa* and *Pseudotsuga taxifolia* in Benton County.

5. PORIA HUMILIS Murrill

Fructifications annual, of at least two types—one type grows in lawns encrusting the bases of grass culms, is 2-7 mm. thick, and, due to conditions, mainly chambered, although a porose condition may be found in places; the second type encrusts the bases of alfalfa stems in fields, the fructification growing up the stem to a height of 3-4 cm., producing shallow pores around the upper limits of growth and deeper pores below; in the second type pileate conditions are never seen, the width of the fungus being confined to the width of the stem on which it is supported and pores occurring on all sides; *tubes* 0.5-6 mm. long, white to cream-color; *pores* white to cream-color, 1-3 or 4 per mm., dissepiments 90-140 μ thick; *context* compact, woven of hyaline *hyphae*, 3-4 μ thick, not encrusted; *basidia* club-shaped, 14 x 4.5-5 μ, with 4 sterigmata 2.5-3 μ long; *spores* abundant, 4-7 x 2.5-3.5 μ, ovate to cylindrical, not curved; *hyphal pegs* occasional, up to 20-25μ long; cystidia and clamp connections not seen.

On *Medicago sativa* in Jackson County; on grass stems in a lawn in Washington County.

6. POLYPORUS VERSIPORUS Pers.

Annual, becoming widely effused from 2 cm. to 10 or 15 feet along the under side of dead trees, 0.5-2 mm. thick; *margin* white to cream-colored, usually fertile from the start; *tubes* 0.5-2 mm. long, dissepiments 60-120 μ thick; *pores* white to cream-colored, becoming strongly irpiciform, 1-4 per mm., irpiciform teeth more or less elongated, tubes inserted more or less irregularly; *hyphae* 3 μ in diameter, thin-walled, hyaline; *basidia* club-shaped, 16.5 x 3.5 μ with 4 sterigmata 1.4 μ long; *spores* ovate to subglobose, hyaline, with 1 oil drop, 4.2-5.6 x 2.8-3.5 μ; *clamp connections* found at the base of

the basidia but they are small and inconspicuous; cystidia and hyphal pegs not seen.

On *Alnus oregana, Acer macrophyllum, Quercus Garryana,* etc., in Benton, Douglas, Lane and Lincoln Counties. One collection on *Pinus contorta* from Lincoln County was referred here.

7. PORIA SUBACIDA (Peck) Sacc., var. TUBERCULOSA (Peck) Sacc.

Annual, effused up to 10-20 cm. along the underside of branches and logs; fructification 1-4 mm. thick; *margin* thick, cottony, soon porose, of the same color as the tubes; fructifications having numerous tuberculate sterile humps of tissue throughout the hymenial area—expanded when the hymenium is in active growth, becoming depressed spots of more or less resinous appearance when dry; *tubes* 0.5-3.5 mm. long cream-colored throughout; *pores* cream-colored, 3-4 per mm., dissepiments 75-160 μ thick; *context* continuous throughout the fructification, with locally scattered to generally abundant crystals; *hyphae* hyaline, 2-3 μ in diameter; *basidia* club-shaped, 14 x 6-7 μ, with 4 sterigmata 2.5 μ long; *spores* ovate, with 1 large central oil drop, hyaline, 3.7-5 x 3.2-3.5 μ; cystidia, hyphal pegs and clamp connections not seen.

On *Alnus oregana* in Coos, Douglas and Lincoln Counties.

8. PORIA ALBIPELLUCIDA Baxter

Fructification thin, annual; at first 0.5-1 cm. in diameter, later becoming confluent for 2-10 cm, or more, 0.5-2 mm. thick; *margin* porose from the start, white pellucid, separable, becoming whitish-gray; *tubes* 0.5-2.5 mm. long, white pellucid throughout; *pores* 1.5-3 per mm.; dissepiments 75-175 μ thick; *context* composed of two types of hyphae: densely woven hyaline hyphae in the trama and subiculum 2-2.5 μ wide; and the hymenium arising from red-staining, loosely and irregularly interwoven hyphae 3.5 μ in diameter scattered through the trama; *basidia* 18 x 6.6.5 μ, club-shaped, with 4 sterigmata 2.2.5 μ long; *spores* ovate, with 1 large central oil drop, 4.5-5 x 3.5-4.5 μ, hyaline; cystidia, hyphal pegs and clamp connections not seen.

On rotten wood of *Pseudotsuga taxifolia* and bark of *Alnus oregana* in Douglas, Lane, Lincoln and Multnomah Counties.

9. PORIA TENUIS (Schw.) M. C. Cooke

Fructification annual; *margin* definite to indefinite, cobwebby to narrowly floccose, then pores, sometimes with small white rhizomorphs, easily separable; *tubes* 0.5-3 mm. long; *pores* white to cream-colored, 2-4 per mm.; *hyphae* 3-4 μ in diameter; *basidia* club-shaped, 14 x 5.5-6 μ, with 4 sterigmata which are very short; *spores* ovate, hyaline or faintly yellowish, 3.9-4.2 x 3.2-3.5 μ; cystidia, hyphal pegs and clamp connections not seen.

On rotten wood of conifers including *Pseudotsuga taxifolia* and *Thujas plicata* among others, in Benton, Lane, Lincoln and Marion Counties.

10. PORIA VAILLANTII (DC. ex Fr.) M. C. Cooke

Fructification annual, 1-2 mm., rarely 4 mm., thick; *margin* soon fertile, very narrow, more or less fimbriate, in certain habitats with white rhizomorphs; easily separable; *tubes* 1-2, rarely 4 mm., long; *pores* 2-3 per mm., with dissepiments 90-150 μ thick; *hyphae* hyaline, 3.5-4.5 μ in diameter; *basidia* club-shaped, 16.5-17 x 4.5-5 μ, with 4 sterigmata 3.5-4.5 μ long; *spores* ovate, hyaline, with 1 large central oil drop, 3.5-5 x 2.8-4.2 μ; *clamp connections* present at the base of the basidia; cystidia and hyphal pegs not seen.

On the ground, duff, rotten or burned wood, structural wood in greenhouses, etc., in Benton, Douglas, Linn and Marion Counties.

11. PORIA MOLLUSCA (Pers. ex Fr.) M. C. Cooke

Annual, effused for several cm.; *margin* thin, cobwebby, white; *tubes* white, then cream-colored; *pores* white to cream-color, 1-3 per mm., with dissepiments 100-150 μ thick; *context* loose, floccose, of large, thin-walled, hyaline *hyphae* 2.5-3 μ thick, branching at the occasional large *clamp connections; basidia* 10-16 x 4-5 μ, club-shaped, with 4 sterigmata 4 μ long; spores globose, hyaline, thick-walled, apparently without oil drops, 3-4 x 2.5-2.8 μ; cystidia and hyphal pegs not seen; occasional large agglutinated masses of hyphae present on the hymenium, the masses 100-150 μ in diameter.

On rotten *Pseudotsuga taxifolia,* in Benton County.

12. PORIA MYCELIOSA Peck

Fructification annual, not becoming very widely effused; *margin* cottony, white to cream-color, adnate or slightly separable; *tubes* 1-2 mm. long, white to cream-color; *pores* white to cream-color, 1-3 per mm.; *context* cottony, *tubes* more or less trametoid; *hyphae* loosely interwoven, not encrusted, 3-4 μ in diameter, frequently septate; *basidia* 6.5 x 3.5 μ, club-shaped or oblong, fasciculate, with 4 sterigmata 2.5-3 μ long; *spores* 3-4.5 x 3-3.5 μ, ovate to round, with 1 oil drop; *clamp connections* well developed at each septum; *ampullae* rarely present, up to 7.5 μ in diameter; cystidia and hyphal pegs not seen.

On rotten conifer wood in Benton and Lincoln Counties.

13. PORIA AMBIGUA Bres.

Annual, effused for 10-20 cm. or more; *margin* white to dull cream-color, inseparable; *tubes* 0.5-4 mm. long, white to cream-color throughout; *pores* white to cream-color, 1-3 per mm.; dissepiments 125-300 μ thick; *hyphae* 2-3 μ in diameter, thin-walled; *basidia* club-shaped, 17 x 8-8.5 μ, with 4 sterigmata 11.5 μ long; *spores* cylindrical, not curved, hyaline, more or less granular, 8-9.5 x 3-3.5 μ; clamp connections, hyphal pegs and cystidia not seen.

On *Quercus Garryana* in Benton County.

14. PORIA FLAVICANS (Karst.) Sacc. & Syd.

Fructifications annual, effused up to 5 cm.; *margin* very narrow, more or less fimbriate, adnate, white at all times; *tubes* whitish to yellowish; *pores* at

first white, then yellowish, 2-4 per mm., ovate, more or less angular, dissepiments 50-150 μ thick; *hyphae* more or less encrusted, 3 μ in diameter, thin-walled; *basidia* club-shaped, constructed in the middle probably because of pressure of the hymenium beyond which the mature basidium doubles its immature length before producing or discharging the spores; *basidia* 14.5 x 5.5 μ, with 4 sterigmata 4 μ long; *spores* ovate to short cylindric, hyaline, with 1-2 oil drops, 3.3-4.2 x 1.6-2.3 μ; *cystidia* capitate, encrusted at the apex; hyphal pegs and clamp connections not seen.

On rotten *Pseudotsuga taxifolia* in Benton County.

15. PORIA GRISEOALBA (Peck) Sacc.

Annual, effused up to 6 cm.; *margin* adnate, more or less fimbriate, white or clay-color; *pores* white to clay-color, 1-3 per mm.; dissepiments 50-75 μ wide; *context* of loosely interwoven hyphae which are deeply encrusted with brownish crystals; *hyphae* thin-walled, 1.8-2 μ wide; *basidia* 10 x 3.5 μ, club-shaped, with 4 sterigmata 2 μ long; *spores* 3.5-4 x 1.7-2 μ, allantoid, with 2 oil drops, hyaline; cystidia, hyphal pegs and clamp connections not seen.

On rotten wood of *Alnus oregana*, Benton County.

16. PORIA VAPORARIA (Pers. ex Fr.) M. C. Cooke

Annual, effused up to 5-8 cm.; *margin* white at first, broad, fimbriate, becoming porose, inseparable; *tubes* white to cream-color, 0.5-2 mm. long, becoming irpiciform in age; *pores* white to cream-color, 2-4 per mm., ovate; dissepiments 60-200 μ thick; *context* interwoven of hyaline *hyphae* 3-4 μ in diameter, thick-walled; *basidia* 14 x 2.5-3 μ, club-shaped, with 4 sterigmata 3-3.5 μ long; *spores* allantoid, hyaline, with 2 oil drops, 5-6.6 x 1.5-2.2 μ; cystidia, hyphal pegs and clamp connections not seen.

On very rotten wood of *Pseudotsuga taxifolia*, Benton County; and on bark of *Alnus oregana*, Hood River County.

17. PORIA CRASSA (Karst.) Sacc.

Annual, effused up to 5-10 cm.; *margin* white, soon porose, inseparable; *tubes* 0.5-1.5 mm. long, white to pale sulphurous throughout; *pores* pale sulphurous, 3-5 per mm.; fructification exceedingly chalky; *hyphae* hyaline, 2-2.5 μ in diameter, thin-walled; *basidia* 5.6 x 2.8 μ, subglobose to somewhat club-shaped, with 4 sterigmata 3 μ long; *spores* not seen in several mounts made; cystidia, hyphal pegs anl clamp connections not seen.

On burned log of *Pseudotsuga taxifolia*, in Benton County.

18. PORIA LENIS (Karst.) Sacc.

Annual, effused up to 10-15 cm. or more; *margin* well defined or cottony, soon becoming fertile, inseparable, usually cream-color but occasionally white; *tubes* 0.5-2 mm. long, white to cream; *pores* white to cream, glistening with a silky sheen in side views in certain light, 6-8 per mm., round, ovate or angular; *context* continuous, of compact, woven, hyaline *hyphae* 2.5 μ thick, thin-

walled; dissepiments 35-80 μ thick; *basidia* 10-12 x 4.5-5 μ, broader above, club-shaped, with 4 sterigmata mostly 2-2.5 μ long; *spores* lunate, strongly curved, with an oil drop in each end, 2.8-4 x 1-1.4 μ; occasional *hyphal pegs* extend 8-10 μ beyond the hymenium into the tube and are capitate; cystidia and clamp connections not seen.

On Pseudotsuga taxifolia, Pinus contorta, Picea sitchensis, Libocedrus decurrens and *Quercus Garryana* in Benton, Douglas, Lane, Lincoln and Linn Counties.

19. PORIA VULGARIS S. F. Gray

Annual, effused for 5-8 cm. or more; *margin* white, soon becoming fertile, adnate; *tubes* 1 mm. long, cream-color or darker, white when fresh; *pores* white when fresh, drying cream to darker, 4-5 per mm., dissepiments 55-90 μ thick; *hyphae* interwoven throughout subiculum and trama, thin-walled, 3-4 μ in diameter; *basidia* club-shaped or ovate, 9-12 x 5.5-8 μ; *spores* allantoid, not lunate, 3.4-4.2 x 1.2-1.4 μ; cystidia, hyphal pegs and clamp connections not seen.

On very rotten logs of *Pseudotsuga taxifolia* in Benton County.

20. PORIA UNDATA (Pers.) Bres.

Annual, effused up to 7 cm.; *margin* soon fertile, curling back in drying, white to dark cream-color; *tubes* 1-3 mm. long, white to dark cream-color; *pores* dark cream-color, 5-8 per mm., round, ovate, squarish or angular; dissepiments 30-50 μ thick; *hyphae* hyaline, 3-4 μ in diameter, thick-walled; *basidia* club-shaped, 18 x 7 μ; *spores* ovate to spherical, 4.2-6 x 3.8-6 μ, mostly 6 x 4 μ, globose, hyaline, with 1 large central oil drop; *hyphal pegs* occur occasionally as blunt-ended hyphal tips protruding into the tubes up to 25 μ beyond the hymenium; cystidia and clamp connections not seen.

On rotten logs of *Pseudotsuga taxifolia* in Benton County.

21. PORIA UNITA (Pers.) Sacc.

Perennial, effused 20-30 cm. or more, 5-10 cm. broad; *margin* definite, not fimbriate, becoming fertile, white at first, becoming yellow; the normal color cream, dark cream, or yellowish cream; *tubes* 2-8 mm. long, indistinctly stratified in several layers, separable from the substratum in sheets although the margins are adnate; *pores* white or cream, then dark cream-yellow, 3-4 or 6 per mm., angular to ovoid, with dissepiments 50-75 μ thick; *hyphae* 2.5-3.5 μ in diameter, thin-walled, hyaline; *basidia* club-shaped, 16-18 x 6-7 μ; *spores* 3.4-5 x 2.8-3.4 μ, oval or spherical, with 1 oil drop; cystidia, hyphal pegs and clamp connections not seen.

Material of this species is usually referred in the United States to *Poria medulla-panis* (Pers. ex Fr.) M. C. Cooke. Dr. Baxter, in a recent letter to the writer, reported that he feels that Donk's interpretation of the situation is correct. Donk (20) includes this species because of its usually truncate spores in his *"Ganodermoideae"*; since this is a perennial species, it is possible that it should be placed in *Ungulina*.

On *Pseudotsuga taxifolia* and *Quercus Garryana* in Benton and Douglas Counties.

22. PORIA SUBFUSCOFLAVIDA (Rostk.) Sacc.

Annual, fructifications up to 2.5-3 cm. in diameter; *margin* definite, 1-3 mm. broad, later fertile, white, inseparable or nearly so; *tubes* 0.5-1 mm. long, white at the subiculum, white to ashy at the mouth; *pores* ashy in older portions of the specimen, white in younger portions, 4-5 per mm.; dissepiments 60-275 μ thick; *hyphae* 2-2.5 μ thick, thin-walled; *basidia* 9-10.5 x 2-4.5 μ, club-shaped, elongated when producing spores, with sterigmata 4-5 μ long; *spores* allantoid, with 1 large central oil drop, hyaline, 5.5-5.7 x 1.9-2.1 μ; cystidia, hyphal pegs and clamp connections not seen.

On rotten *Pinus contorta* logs in Lane and Lincoln Counties.

23. POLYPORUS ADUSTUS (Willd.) Fries

In the Herbarium of Oregon State College is one specimen of a resupinate form of this species; since the species may be confused with species of *Poria* because of the occasional resupinate habit it is inserted here. Normally one finds at least a small fructification with a reflexed pileus in association with resupinate material. The specimen at hand has a smoky, nearly black, hymenophore, with what appears to be a true sporophore, these two regions being separated by a distinct line of hyphae; margins white to pallid, silky, becoming smoky as the pores start to form; tubes 1 mm. long, subiculum 1 mm. thick; pores very small, 4-8 per mm. to 10 per mm. in some portions of the fructification.

On *Pseudotsuga taxifolia* in Benton County.

24. PORIA INCRASSATA (Berk. & Curt.) Burt

Fructification annual, 3-6 mm. thick, becoming effused up to 10-20 cm. or more long; *tubes* 3-6 mm. long, not stratified, olive-black throughout in dry material; *pores* black in dry material, 2-3 per mm., becoming very brittle when dry and impossible to section with a razor blade, although they soften quickly in KOH; *context* of trama of strictly parallel hyphae some of which in the old specimens studied stain red; *hyphae* very compact, reported by Burt as being hyaline (but a brown precipitate is formed in mounts in KOH) 2.5-3.5 μ in diameter; *subiculum* papery, very thin, peeling from the tubes, whitish-gray; *basidia* not seen in a number of mounts; *spores* very abundant, large, 9.5-12 x 5.5-7 μ, with a hyaline apiculus and greenish walls 0.7-1 μ thick, appearing black or greenish-black in mass, some at least staining red inside the greenish walls in phloxine; *spores* evidently germinating readily in the tubes, young hyphae, apparently from the spores, being present in mounts made from the tubes, hyaline, 2.5-4.5 μ in diameter, and with clamp connections at the septa; clamps not otherwise seen; cystidia and hyphal pegs not seen.

Rhizomorphs 3-10 mm. in diameter, compressed, oval or round, extending for great distances from a source of water supply to the white papery mycelial fans which cover large areas and which in favorable places terminate in the fructification.

On structural wood of *Pseudotsuga taxifolia,* in Benton and Multnomah Counties.

25. PORIA ALBOLUTESCENS (Romell) Baxter

A striking yellow *Poria* was brought to our attention; the material was sterile, probably young. Reference of this material to the above species is tentative. Fructification sulphur yellow; *subiculum* white, *margin* white, narrow, soon porose; in growing over rough places on the substratum, such as mosses, the fructification taking on a pileate aspect without being truly pileate; *basidia* crowded, apparently none fertile in several mounts; basidia subtended by well developed *clamp connections.* Macroscopically and partially microscopically the specimen answers the description of *Poria albolutea* which has abundant clamps, ampullae, urniform basidia, and minutely asperulate spores; however, this specimen has no observed spores, the basidia do not appear to be of the urniform type and there are no ampullae. Bourdot & Galzin suggest that the two mentioned species may be easily confused.

Covering mosses and bark on logs of *Tsuga heterophylla,* in Benton County.

26. PORIA BRESADOLAE Bourd. & Galz.

Annual, effused for 5-10 cm.; *margin* white, sterile at first, soon becoming porose, closely adnate, remaining white in older specimens; *tubes* 0.5-1 mm. long, with white subiculum and white mouths, but with a zone of tissue in the tubes encrusted with red or brown crystalline matter which shows through the hyaline tissue of the pore mouths when the fructification is bruised or dry; *colored area* 100-150 μ wide, only in the dissepiments of the tubes; *pores* white when young, showing red when bruised or dry, 3-4, rarely 5, per mm., dissepiments very thin; *basidia* fasciculate, club-shaped, 8-9 x 414.5 μ, with 4 sterigmata 2.5-3 μ long; *spores* allantoid, with 1 to several oil drops, 4.7-5.4 x 1.9-2.4 μ; *clamp connections* present at the bases of the basidia; cystidia and hyphal pegs not seen.

This species can easily be confused with *Poria sanguinolenta* from which it differs in the size and shape of the spores.

On rotten wood of *Pinus contorta* and several unidentified hosts in Benton, Lane and Multnomah Counties.

27. POLYPORUS ALBOLUTEUS Ell. & Ev.

One specimen represents this species in the Oregon State College collections; it is included here because of the characteristic growth form which may be mistaken for resupinate. The pileus is formed below the middle of fallen conifer logs, is very thick and spongy, and is composed of loosely interwoven floccose hyphae; fructification orange-red, pore mouths bordered in white; tubes inserted in the context as in *Trametes;* annual, the fructification soon after maturity being eaten by specific insect parasites; *tubes* from 1-3 cm. long; *pores* round or angular, 1-4 mm. in diameter, with thick, floccose dissepiments. Baxter (10) gives an excellent detailed account of this species. On this species

Murrill based his genus *Aurantioporellus*, a disposition of the species which the writer finds acceptable.

On an unidentified coniferous host, in Wallowa County.

28. PORIA SPISSA (Schw. apud Fr.) M. C. Cooke

Annual, effused for 2-3 cm.; *margin* pale orange, 1-3 mm. broad, becoming fertile, inseparable; *tubes* 0.5-1 mm. long, pale orange near the subiculum, blood red at the mouths when dry, red when fresh, becoming darker red when bruised; *pores* light red when young, blood red when older, 3-4 per mm.; *context* brown encrusted, but more heavily so near the mouths of the tubes; basidia 11-12 x 4.5-5 μ, club-shaped, with 4 sterigmata 1.7-2.8 μ long; *spores* allantoid, 5.6 x 2.1 μ; cystidia, clamp connections, and hyphal pegs not seen.

On rotten wood of *Acer macrophyllum*, in Benton County.

29. PORIA PURPUREA (Fr.) M. C. Cooke

Annual, covering large areas of the substratum but the individual fructifications limited in size to 1-3 cm. in diameter; 0.5-1 mm. thick; *margin* thin, fimbriate, adnate, pale orange to reddish, becoming purple; *tubes* 0.5-1 mm. long, in favorable places up to 2 mm. long, more or less irpiciform, merulioid, dark purple throughout (when collected in wet weather the fructification bled a dark red juice); *pores* dark purple throughout, with dissepiments 60-75 μ thick; *context* composed of hyaline *hyphae* 3 μ thick which are heavily encrusted with dark red crystals; *basidia* club-shaped, 16-17 x 4-4.5 μ long; *spores* fairly regular in size throughout the mount, measuring 5.6 x 2.0 μ allantoid, hyaline, without oil drops; cystidia, hyphal pegs and clamp connections not seen.

On an old fence post of *Quercus Garryana*, in Benton County.

30. TRAMETES ABIETIS (Karst.) Sacc.

Fructification widely effused up to 25 cm. or more along the underside of coniferous logs; *margins* narrow, soon fertile, brown, cottony; fructification adnate except in older parts; *pores* averaging 1-6 per mm., round, ovate, angular or even daedaleoid; dissepiments narrow; usually annual, but sometimes with two layers of seasonal growth; in one unduplicated mount hyaline, globose *spores* seen attached to basidia in the upper portions of the shallow tubes, while in other mounts ferruginous spores of the same size and shape were found near the mouths of the tubes; brown setae in the hymenium.

While the material studied is here treated as a separate species among the resupinate pore fungi, its structure has convinced most workers, including the writer, that it is a variety or synonym of the normally pileate species *Trametes Pini*, which has also been classed in the genus *Fomes* (because of its perennial habit) and the genus *Porodaedalea* (because of its otherwise confusing trametoid-daedaleoid-fomitoid characters). The writer believes it to fall more naturally in the latter genus.

On rotten or charred wood of *Pseudotsuga taxifolia*, in Benton, Lane and Marion Counties.

31. PORIA WEIRII Murrill

Perennial, broadly effused to 20 or 30 cm.; old layers brown stuffed, separated from new layers by a layer of heavily encrusted hyphae which have continued downward from the stuffed tubes and which form a partial intermediate layer between the old and new tubes; *margins* receding, inseparable, tomentose, honey-yellow, yellow-brown, then brown and fertile; *tubes* 1-2.5 mm. long, stratified, brown throughout, more or less cinereous at the mouths; *pores* brown, 4-6 per mm., round to ovate; context made up of at least two types of hyphae: a floccose fertile series which is brown, becoming hyaline at the tips near and in the hymenium; and a sterile series bearing heavily encrusted hyphae which produce the denser portions of the stuffing of the older tubes and the setae which later appear to proliferate to develop the tube stuffing; dissepiments 35-135 μ thick; *basidia* globose, 10-11 x 5.5-6 μ; *spores* subglobose, 5-6 x 3-4 μ, hyaline, no oil drops seen; *setae* brown, heavily encrusted with crystals, 30-50 x 7-9 μ or more, with a very narrow lumen; globose, attenuate *cystidia* are present which are hyaline and 15-20 x 5-8 μ; hyphal pegs and clamp connections not seen.

A severe butt rot of *Thuja plicata*, rarely collected in fruit—Marion County—but symptoms occasionally seen throughout the range of the host in the state.

32. PORIA FERRUGINOSA ([Schrad.] ex Fr.) M. C. Cooke

Perennial, usually resupinate, rarely more or less pileate; fructification effused up to several yards in extent, sometimes covering the underside of a long-fallen log; 2-4-10-12 mm. thick; old layers stuffed, not always distinguishable from the subiculum because of the complete filling of the tubes and the apparent proliferation of such hymenial structures as setae; *margin* becoming porose soon, honey-colored to dark brown, pulling away from the substratum in drying in some specimens, resinous in the pileate specimens rather than showing the concave surfaces of incomplete tubes as in other pseudopileate Poriae; *tubes* 2-10-12 mm. long, stratified, but stratification evident only by the degree of stuffing of the older portions of the tubes, brown throughout; *pores* dark brown to yellow-brown, 4-5 per mm., ovate or round, rarely slightly angular; dissepiments 30-140 μ thick; hyphae 2-3 μ in diameter, lumen one-third to one-half the diameter of the hypha; *basidia* 10-12 x 5.5-6 μ, club-shaped, with 4 sterigmata 2-3 μ long; *spores* 3.8-5 x 2.5-3 μ, ovate; cystidia none; *hyphal* pegs present in the older portions of the tubes, becoming elongate and probably the origin of the mycelial stuffing found in the older portions of the tubes and in old specimens; *setae* brown, 28-35 x 5.5-7 μ, with narrow lumen 2 μ broad which extends to the tip of the seta; no clamp connections seen.

On *Quercus Garryana, Alnus oregana* and other hardwoods, at least in Benton and Lincoln Counties.

33. PORIA FERREA (Pers.) Kauffman

Perennial; fructification appearing like that of *Poria ferruginosa* from which it is separated only on microscopic characters; *tubes* 2-6-12 mm. long, brown; *pores* brown, 4-8 per mm., ovate; dissepiments 30-100 μ thick; *basidia* more or less ovate, 8.5-9 x 4-4.5 μ; *spores* hyaline, 5.5-7 x 1.8-2.5 μ; cystidia and hyphal pegs not seen; *setae* brown, subulate, 22-40 x 5-5.7 μ, formed by a projection of a hyphal tip from which it is not separated by a septum; clamp connections not seen.

On slash and rotten logs of *Alnus oregana, Quercus Garryana,* etc., at least in Benton, Lane, Lincoln, Linn and Multnomah Counties.

In addition a number of specimens have been collected in Benton, Douglas, Lane and Lincoln Counties in which no spores could be found because the specimen was either too old, too young, or inactive at the time of collection. Without the spores they can be referred to either *Poria ferrea* or *P. ferruginosa.* One of these two species has been found well developed on *Castanopsis chrysophylla.*

34. PORIA CARBONIA (Berk. & Curt.) Lloyd

Annual, always resupinate, always on burned wood, effused up to 15 cm. or more; *margin* of sterile hyphae none, although there may be small brown rhizomorphs penetrating the substratum; *tubes* 1-1.5 mm. long, not stratified, brown; *pores* brown, 2-3 per mm.; *context* continuous, trametoid, brown; dissepiments thin, averaging 100 μ thick; *basidia* club-shaped, 12-14 x 5-6 μ with 4 sterigmata 2-2.5 μ long; *spores* hyaline, 7-10 x 3-3.5 μ, allantoid, with several yellow oil drops; neither cystidia nor hyphal pegs nor clamp connections seen.

On charred *Pseudotsuga taxifolia* logs, in Benton and Lane Coutnies.

35. PORIA TSUGINA (Murr.) Sacc. & Trott.

Perennial, effused 15-20 cm. or more, up to 3 cm. thick; *margin* sometimes pulled away from substratum in drying, dark brown in older portions, successive layers producing receding marginal growth; *tubes* up to 10 mm. or more long without definite stratification, but average space between strata is 1-2.5 mm.; *tubes* becoming white-cottony-stuffed in age; areas of seasonal growth marked by dark brown context line up to 0.5 mm. thick; apparently dead areas separated from active areas by a black line—similar to the line produced by *Polyporus versicolor* at the margin of its rotted areas in logs, rather than to the type of line separating seasonal growth layers in *Fomes nigrolimitatus; pores* brown, 6-7 per mm., surface cracked in drying in older portions of some specimens; brown structural *hyphae* 3-4 μ wide, walls thick, lumen only one-third the width, without encrustations, septa rare; tubes lined with pale-yellow *hyphae* 3 μ in diameter which apparently give rise to the hymenium, thin-walled, not encrusted; a 9 mm. longitudinal section showed 1-2-3 seasons of growth continuous with each other in a single tube and fertile from top to bottom with no indication of stuffing; *basidia* 11-12.5 x 7.5-9 μ; *spores* spherical,

hyaline, 5.7-7.5 μ in diameter, with 1 large oil drop; hyphal pegs, cystidia, setae and clamp connections not seen.

Baxter considers this species at least conspecific with Karsten's *Fomes robustus* of Europe and the eastern United States because of identical, or nearly identical, critical characters. Overholtz and Campbell consider it a variety of *Fomes robustus*. Murrill placed it in his resupinate genus *Fomitiporia*.

Found only on *Tsuga heterophylla*, in Benton and Lincoln Counties.

Four additional species have been found which the writer has been unable to assign to any species in the literature. This may have been because of insufficient critical study, lack of material for comparison, lack of a more comprehensive knowledge of the group, or for some other reason. It is felt at present that giving these species names would only add to the confusion of *Poria* literature and because of lack of time no critical comparative studies were attempted. These species are briefly cited below:

36. PORIA sp.

Annual; adequate material for study obtainable only in late September and early October, other collections appearing sterile; subfleshy, 2-8 mm. thick when dry, with a white *margin* which is soon fertile, inseparable, effused over large areas of logs and stumps; *tubes* 2-10 mm. long, white; *pores* white, 2-3 per mm., dissepiments up to 300 μ thick; *pores* round to angular; *context* trameoid, of hyaline, loosely interwoven, somewhat branched hyphae 2.5-4 μ thick; *basidia* 4.5 x 12 μ, club-shaped, with 2-4 sterigmata 3.5-4 μ long; *spores* hyaline, ovate to cylindric, with 1 oil drop, 2.3-3 x 4.4-5.6 μ; cystidia, hyphal pegs and clamp connections not seen. With an anise odor when fresh.

On *Pseudotsuga taxifolia*. Benton Co.: C. E. Owens, O.S.C. 2049; W.B.C. 9787, 9812; M. Doty 608. Coos Co.: M. Doty and M. Douhan 35. Douglas Co.: D. P. Rogers 511, 517. Lane Co.: M. Doty 609, 610. Lincoln Co.: M. Doty 46; W.B.C. 9501. Marion Co.: W.B.C. 13001.

37. PORIA sp.

Annual, 1-3 cm. broad; *margin* cottony, more or less adnate, white to cream-colored; *tubes* 0.5-1.5 mm. long, yellowish throughout; *pores* dull yellow, brittle when cut, 4-6 per mm., angular, dissepiments thin; *basidia* club-shaped to globose, 9-10 x 5-6 μ, with 4 sterigmata 2.5-3 μ long; *spores* spherical, hyaline, with 1 large oil drop, 3-5 μ in diameter; *cystidia* present, formed of tips of sterile hyphae which are encrusted at the tips with ovate, cell-like structures, 14-28 μ long, becoming club-shaped and 7-10 μ in diameter; hyphal pegs and clamp connections not seen.

On rotten wood. Benton Co.: S. M. Zeller, O.S.C. 8565.

38. PORIA sp.

Several collections of an undetermined yellow *Poria* are in the Oregon State College herbarium. All seem to be sterile. *Margin* narrow, soon porose;

borders of *pores* may turn reddish on drying, no color change being noted when fresh specimens were bruised; specimens effused up to 10 cm., becoming brittle and cartilaginous when dry; pores 1-4-6 per mm., with very thin dissepiments. The dark citrinous color is characteristic.

On rotten logs of *Pseudotsuga taxifolia*. Benton Co.: D. Robinson; W.B.C. 10084. Douglas Co.: M. Doty 606.

39. PORIA sp.

Annual, effused up to 4 x 12 cm. or more; *margin* definite, inseparable, more or less fimbriate, pale to rosy purple, soon porose; *tubes* not merulioid, 0.5-1.5 mm. long, purple to pale rose purple throughout; *pores* angular, 2-4 per mm., with dissepiments 60-80 μ thick, pale to dark purple; *context* of the subiculum and trama very thin, continuous, of interwoven hyphae of two types: a sterile, unstaining series which is encrusted with reddish or brownish crystals; and a fertile series 3 μ in diameter which stains red in phloxine and which appears to produce the basidia; *basidia* club-shaped, 12-13 x 4-5 μ, with 4 sterigmata 4 μ long; *spores* cylindric, straight, with 1-2 oil drops, hyaline, 3.2-3.5 x 1.5-1.9 μ; a few *cystidia* are present, encrusted at the apex with crystals soluble in KOH, exserted 20 μ beyond the hymenium 4 μ in diameter; clamp connections and hyphal pegs not seen.

On partially rotten logs of *Quercus Garryana*. Benton Co.: W.B.C. 10076, 13030. Lincoln Co.: D. P. Rogers 388.

In addition to the above mentioned 39 species, several species have been listed by various writers as occurring in Oregon. These have not been seen by the writer.

Baxter (2-10) records the following resupinate or semi-resupinate species in addition to some of those adready discussed: *Poria xantha* (Fr.) M. C. Cooke, *Polyporus sericeo-mollis* Romell, *Fomes nigrolimitatus* (Romell) Egeland, and *Trametes isabellina* Fr.

Kauffman (24) records *Poria mollusca* (Pers. ex Fr.) M. C. Cooke and *Poria medulla-panis* "var. *colorata* Overholtz" as occurring on Mount Hood, although he does not record any *Porias* in his Siskiyou Mountain paper (25).

Zeller (45, 46) records *Poria contigua* (Pers.) Karst. among other species reported above for Oregon. All specimens found in the Oregon State College herbarium under this name are now referred to the *Poria ferrea-Poria ferruginosa* complex. The specimen reported by Zeller as *Poria sanguinolenta* on the basis of a tentative determination by Burt is described above under *Poria purpurea*. A specimen collected by J. L. Meilke and identified by Overholtz as *P. emollita* Fr. appears to be sterile and exhibits features referable to the *Poria ferrea-P. ferruginosa* complex.

A complete series of specimens of the species studied is deposited in the Mycological Herbarium at Oregon State College. Complete series of species

are in the herbaria of the writer at the University of Cincinnati and of D. V. Baxter.

A list of 46 titles used in reference to this problem follows. Titles not referred to by number in the text of the paper were used in interpretation of morphological and physiological problems involved in the study of the group.

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The Lichen Genus Cladonia in Wisconsin

John W. Thomson, Jr.

In recent years interest in lichens has revived and a more critical interpretation of the genus Cladonia in this country, based on the views of the European specialists Vainio and Sandstede, has been in progress. This interest and interpretation has been fostered largely by the efforts of A. W. Evans and the late C. A. Robbins and R. H. Torrey. The present paper is in accordance with these treatments rather than with the broader interpretations of Fink and Tuckerman. Use has been made of chemical aids in the distinction of species; in particular the use of paraphenylenediamine as recommended by Asahina for the detection of fumarprotocetraric and thamnolic acids in certain species has helped greatly.

From the point of view of the lichenologist, Wisconsin is a little known state. In 1848 C. C. Parry collected a few lichens in either Wisconsin or Minnesota. Bruce Fink reported upon these in 1895 (4). There were five *Cladoniae* listed in these collections: *C. cristatella, C. gracilis, C. pyxidata, C. squamosa,* and *rangiferina.* In a later paper (5) Fink omits these and lists only one species, *C. macilenta,* among the lichens collected in Wisconsin. No localities are given in either of these records. Vainio (17) reported four species from Wisconsin, two of them apparently being based on specimens in the herbarium of Jean Muller. These are *C. botrytes,* "ad Princeton in Wisconsin Territory (Mull. Arg. Lich. Oreg. p. 363)," and *C. Floerkeana,* "et secundum specim. in herb. Mull. in Wisconsin leg. J. A. Lapham teste Leight. Not. Lichenol. XII, p. 118." *C. cornuta* is reported "ad tamarack in Wisconsin (Lapham)" and *C. crispata,* "Wisconsin (leg. Greene)." In addition to the two specimens credited above to I. A. Lapham, two specimens collected by him in the Penokee Iron Range are still extant in the herbarium of the University of Wisconsin. They are *C. scabriuscula* and *C. gracilis* var. *dilatata.* Tuckerman (16) reported *C. macilenta, C. furcata* a. *crispata, C. gracilis, C. cornuta,* and the indeterminable *C. symphycarpa* b. *epiphylla.*

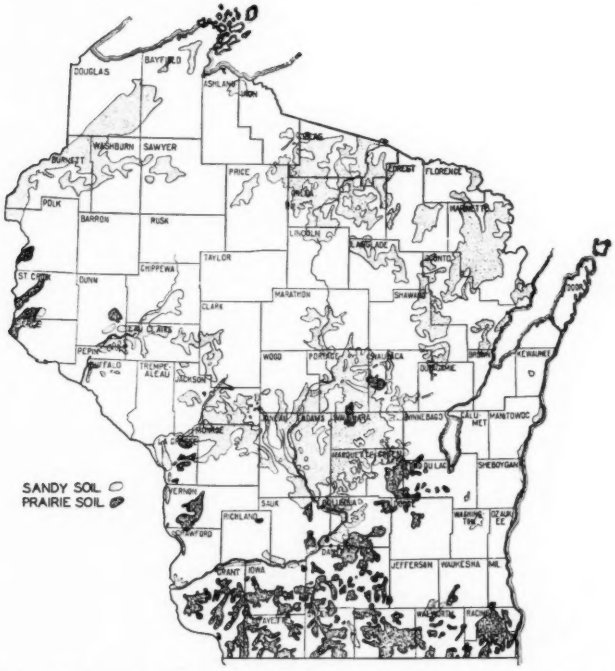
During the summers of 1893 and 1894, Prof. L. S. Cheney collected along the Wisconsin River from Lac Vieux Desert on the Michigan boundary to Wisconsin Dells. Among his collections are 51 specimens representing 17 species of *Cladonia.* These are in the herbarium of the University of Wisconsin, as are four species collected by Heald and Buell in the vicinity of Madison in 1893.

The specimens on which this paper is mainly based were collected by the writer, principally in central and northern Wisconsin, between 1935 and 1941. Collectors to whom I am grateful for additional specimens are: R. I. Evans, L. H. Shinners, Chas. McGraw, M. P. Backus, R. M. Reeve, and Wm.

O'Gara. The specimens, including those collected by the writer, are deposited in the herbarium of the University of Wisconsin. The lichen herbarium of Prof. R. H. Denniston of the University of Wisconsin was also consulted in the preparation of this paper. In the enumeration of the specimens, those listed with dates alone were collected by the writer. For others, the dates and collector's names are given. Specimens in the Denniston herbarium are indicated by (D); specimens in the Yale University Herbarium, but not in the University of Wisconsin Herbarium, are indicated by (Y).

The writer is greatly indebted to Dr. A. W. Evans of the Osborn Botanical Laboratory, Yale University, and to the late Raymond H. Torrey for their ever generous determinations of material sent them. Most of the specimens listed here have been checked by either or both of these men. Grateful acknowledgement is also made to Dr. Evans for suggestions in the preparation of this paper.

Glaciation has left extensive deposits of sand and sandy gravel in central



Map of Wisconsin showing location of counties and areas of sandy soils which are particularly favorable for Cladonias. Courtesy: N. C. Fassett.

and northern Wisconsin (see Map). In these regions the sandy soil is rather acid and *Cladonia* collecting is excellent. Clay banks in the glacial drift, and the peat and tamarack bogs of the poorly drained parts of the glaciated areas add variety to the habitats and to the number of species of *Cladonia* which can be collected. Sandy glacial outwash in the bed of Glacial Lake Wisconsin in central Wisconsin and along the Wisconsin and Mississippi Rivers are fine collecting grounds in the Driftless Area. The glacial meltwaters brought much sandy material down these river valleys and deposited it in large terraces which are well developed at Spring Green, Sauk County, Arena, Iowa County, and near Mazomanie, Dane County. Sand prairies, old fields, and open woods on these terraces support flourishing colonies of *Cladonia*. Southeastern Wisconsin, where glaciation mixed much calcium-bearing material from the underlying belts of limestones with the surface till, and where farming is so intensive, is much less rich in *Cladonia* flora. The rolling ridges and valleys of the Driftless Area are also rather poor. In these areas, *Cladoniae* are confined mainly to species which grow on tree trunks and to local acid conditions such as peat and tamarack bogs. The peat bogs are much more numerous in the kettle topography and other poorly drained portions of glaciated southeastern Wisconsin than in the southwestern Driftless Area, but are also found in the latter in oxbows and under similar undrained conditions.

KEY TO THE WISCONSIN SPECIES OF CLADONIA

Subgenus 1. CLADINA (Nyl.) Vain. Primary thallus crustaceous, soon disappearing, rarely seen. Podetia slender, elongated, much branched, in whorls around gaping axils, arachnoid-tomentose, without cortex but sometimes with pseudo-cortex of scattered areolae, apices minutely 2-8 forked, brownish. Apothecia brown, rare. Plants densely intertangled in large colonies. Commonly called "Reindeer Mosses."

Podetia in dense, irregularly entangled colonies.

Podetia ashy-gray, varying to brownish or greenish. KOH +, yellowish, P +. ..... 1. *C. rangiferina*

Podetia yellowish-green, varying to gray. KOH —.

Peripheral branches curved in one direction, nodding. Areolae grayish, greenish or brownish, interspaces tomentose. P +. ..... 2. *C. sylvatica*

Peripheral branches not distinctly curved and nodding. Areolae whitish to yellowish, the interspaces smooth. P —. ..... 3. *C. mitis*

Podetia forming regular, compact rounded colonies. Color whitish or pale gray. KOH —, P —. ..... 4. *C. alpestris*

Subgenus 2. PYCNOTHELIA Ach. Primary thallus granular-crustaceous, persistent.

Podetia short, stout, simple or short branched, corticate, resembling minute cacti. Apothecia small, brownish-red. KOH +, pale yellow, P —. ..... 5. *C. papillaria*

Subgenus 3. CENOMYCE (Ach.) Th. Fr. Primary thallus with leaf-like squamules, persistent or disappearing.

Series A. *Cocciferae* Del. Apothecia scarlet, rarely flesh colored or whitish.

Section 1. *Subglaucescentes* Vain. Primary squamules grayish-green above, white below. Podetia whitish to grayish-green, often sterile, with blunt or pointed apices.

Primary squamules sorediose, podetia usually densely sorediate, green areas flat rather than verruculose or granulose, denuded surface opaque, white and more or less rough.

Plants negative with KOH and P.

Podetia more or less corticate throughout their entire length. 6. *C. Floerkeana*
Podetia often corticate basally but entirely decorticate above. 7. *C. bacillaris*
Plants turning yellow with KOH, red with P. ..... 8. *C. macilenta*

Primary squamules esorediose, podetia at first covered with squamules, verruculae, or granules, sometimes interspersed with fine soredia, later these disappear leaving the translucent medulla exposed. KOH —, P —. ..... 9. *C. didyma*

Section 2. *Stramineo-flavidae* Vain. Primary squamules yellowish-green above, white or yellowish below, podetia yellowish-green.
Podetia cup-forming, sterile or fertile, sorediate.
Cortex disintegrating, usually sorediate with farinose to granulose soredia. Apothecia large and conspicuous. KOH —, P —. ..... 10. *C. pleurota*

Cortex persistent below, disintegrating above, soredia very fine, whitish or pale yellowish, cups with many sharp-pointed marginal divisions, with small apothecia at the tips. KOH +, yellow; P +. .... 11. *C. digitata*

Podetia not cup-forming, always terminated by apothecia.
Primary squamules not sorediate, decorticate areas between the areolae on podetia whitish. ..... 12. *C. cristatella*

Primary squamules sorediate, decorticate areas between the areolae on the podetia pellucid and darkening. ..... 13. *C. incrassata*

Series B. *Ochrophaeae* Vain. Apothecia brown to flesh colored.
Section 1. *Unciales* (Del.) Vain. Primary thallus disappearing. Podetia disintegrating basally, cylindrical to irregularly swollen, corticate, repeatedly branched and intertangled, spinose tipped. Resembling the Cladinas but distinguished from them by having spinose tips and smooth cortex.
Podetia cupless, stout, irregularly swollen, apices rarely becoming brown.
Podetia pale yellowish-green to brownish-green, usually with axillary perforations, inner surface uniform. ..... 14. *C. uncialis*

Podetia yellowish-gray to pale yellowish-green, axillary perforations lacking on sterile plants, present on fertile, inner surface showing a vague network. ..... 15. *C. caroliniana*

Podetia cup-bearing or cupless, slender, apices usually brownish. ..... 16. *C. amaurocraea*

Section 2. *Chasmariae* (Ach.) Floerke. Primary thallus persistent. Podetia cupless or with open cups (occasionally closed by a perforate membrane), axils usually open and more or less gaping. Apothecia usually small.
Group 1. *Microphyllae* Vain. Primary squamules small to medium sized, margins finely incised to subentire.
Podetia well developed.
Podetia not cup-forming, branched and intertangled, branches often dichotomous, slender and elongated, cortex continuous or areolate, axils usually gaping.
Plants without soredia, podetia whitish or greenish-gray. KOH — or sometimes pale yellow turning to dingy brown. P +. ..... 17. *C. furcata*

Plants sorediate, podetia whitish or greenish gray. KOH —, P +. ..... 18. *C. scabriuscula*

Podetia cupless, with open cups, or with cups closed by a lacerate or punctured membrane. Not much branched and intertangled.
KOH minus.
Podetia cup-forming. Cups partly closed by a lacerate or punctured membrane. P +. ..... 19. *C. multiformis*

Podetia cup-forming (cups sometimes lacking), cups open.
Lacking soredia, margins of cups not inrolled.
Cortex persistent (always present), P —. ..... 20. *C. crispata*

Cortex more or less disintegrating (often lacking over large areas), P — (or nearly so). ..... 21. *C. squamosa*

Sorediate, margins of cups inrolled. P —. ..... 22. *C. cenotea*

KOH plus, yellow; P plus. Podetia short, simple or sparingly branched, cupless, cortex disintegrating, granular sorediate. ..... 23. *C. delicata*

Podetia reduced to short stalks or the apothecia sessile on the primary squamules. KOH —, P +. ..... 24. *C. caespiticia*

Group 2. *Megaphyllae* Vainio. Primary squamules medium sized to large, margins sinuate to subentire.

Podetia lacking, the apothecia sessile on the primary squamules. ..... 25. *C. apodocarpa*

Podetia present, with or without cups, branching irregular or dichotomous. ..... 26. *C. turgida*

Section 3. *Clausae* Vainio. Primary thallus persistent. Podetia cupless or with cups closed by an imperforate membrane, axils usually closed. Apothecia usually medium sized to large.

Podetia gray-green to olive, primary squamules white below.

Group 1. *Podostelides* (Wallr.) Vain. Podetia not cup-forming, usually tipped with apothecia.

Subgroup 1. *Helopodium* (Ach.) Vain. Podetia never sorediose, spermagonia usually restricted to the primary squamules.

Primary squamules small, KOH +, greenish-yellow, becoming brown. Podetia slender, often twisted, cortex composed of dispersed areolae or lacking over large areas, the exposed areas translucent in appearance. P +. ..... 27. *C. mitrula*

Primary squamules medium to large. Podetia usually stout and straight, club-shaped, cortex continuous or composed of more or less dispersed areolae or verruculae.

KOH —, P +. ..... 28. *C. clavulifera*

KOH +.

Podetia torn and fissured, KOH + yellow, not turning red. P —. ..... 29. *C. cariosa*

Podetia not torn and fissured, KOH + yellow, turning red. P — (or nearly so). ..... 30. *C. subcariosa*

Subgroup 2. *Macropus* Vainio. Podetia sorediose, spermagonia restricted to the podetia. Soredia dispersing to leave decorticate chalky white areas.

KOH +, yellow ..... 31. *C. Norrlini*

KOH — ..... 32. *C. decorticata*

Group 2. *Thallostelides* Vainio. Podetia normally cup-forming, often sterile. Cups well expanded or abortive to obsolete, the podetia then blunt or sharp-pointed, often with a minute central depression.

Podetia not sorediose, cortex continuous or composed of areolae, podetia cup-forming.

Cups shallow, 1-5 ranked, cortex smooth.

Proliferations from the margins of the cups ..... 33. *C. gracilis*

Proliferations from the centers of the cups. ..... 34. *C. verticillata*

Cups deep, simple or with apothecia on marginal proliferations, cortex warty-areolate or smooth. ..... 35. *C. pyxidata*

Podetia sorediose, cortex composed of contiguous to dispersed areolae or wanting.

Podetia cup-forming, cups usually definite and well-shaped.

Cups deep (goblet-shaped).

Soredia granular, podetia usually stout.

P + red-orange. ..... 36. *C. chlorophaea*

P —. ..... 37. *C. Grayi*

Soredia farinose.
Podetia moderately stout, KOH —, P +. .....38. *C. conista*
Podetia slender, broadening out gradually into distinct cups, KOH —, P +.
Podetia 1-2 mm. in diameter, 20 mm. high, corticate area restricted to the base. .....39. *C. fimbriata*
Podetia 1-3 mm. in diameter, 40 mm. high, cortex extending to over halfway up the podetium. .....40. *C. major*
Cups shallow (saucer-shaped), narrow to minute or occasionally lacking, podetia slender, granular-sorediate. KOH —, P + or —. .....41. *C. nemoxyna*
Podetia forming irregular cups or cupless.
Podetia elongate, sorediate at tip, mostly corticate and smooth or slightly areolate, cupless and sharp-pointed or with narrow cups. KOH +, P +. .....42. *C. cornuta.*
Podetia shorter, decorticate and sorediate, sometimes corticate toward the base.
Soredia farinose, decorticate areas opaque, primary squamules broad, medium sized to large.
Podetia not producing isidioid granules or squamules in addition to soredia, KOH + brown, P +. .....43. *C. coniocraea*
Podetia producing isidioid granules or squamules in addition to soredia. KOH + pale yellow, P +.....44. *C. borbonica*
Soredia granular, decorticate areas pellucid, primary squamules narrow, medium sized to small. KOH +, P +. .....45. *C. pityrea*
Podetia yellowish, primary squamules yellowish below.
Group 3. *Foliosae* (Bagl. & Carest.) Vain. Primary squamules medium sized, plants turning coppery-green with KOH and $CaCl_2O_2$, podetia cupless, from relatively simple to irregularly branched structures. .....46. *C. strepsilis*
Group 4. *Ochroleucae* Fr. Primary squamules small to medium sized. Podetia slender, simple or branched, cortex areolate, apothecia terminating all podetia, pale brown or flesh-colored. KOH —, P —. .....47. *C. botrytes.*

1. *Cladonia rangiferina* (L.) Web. On sandy soil, on hill tops, in open woods, and in bogs. SAUK: Spring Green, 1936; Devil's Lake, 1936; Parfrey's Glen, 1936. JUNEAU: Necedah, 1936: New Lisbon, 1936. JEFFERSON: Hope Lake bog, 1936. FOREST: Argonne, 1937. ONEIDA: Monico, 1937; Tomahawk Lake, 1941. MONROE: Millston, 1937. MARINETTE: Amberg, 1937. VILAS: Pine Lake, Cheney, 1893; Lac Vieux Desert, Cheney, 1893; Sayner, 1938, 1941. MARATHON: Mosinee, Cheney, 1894; Granite Heights, Cheney, 1894. DANE: Blue Mounds, Denniston, 1921 (D). ADAMS: Roche a cri, Denniston, 1935 (D). WAUPACA: no locality, Denniston, 1921 (D). DOUGLAS: Manitou Falls, Denniston, 1927 (D). WALWORTH: Springfield, Heald and Buell, 1893. In addition to the above collections, two forms of this species have been found in this state; f. *crispata* with densely crowded and intricately entangled branches, and f. *setigera* with scattered or bunched bristle-like outgrowths.

Cladonia rangiferina f. *crispata* Coem. SAUK: Parfrey's Glen, 1936.

Cladonia rangiferina f. *setigera* Oxner. ADAMS: Wisconsin Dells, 1938. SAUK: Baraboo, 1939. BURNETT: Swiss Bridge, L. R. Wilson, 1927 (D).

2. *Cladonia sylvatica* (L.) Hoffm. On sandy soils, on hill tops, in open woods, and in bogs. FOREST: Argonne, 1937. VILAS: Lac Vieux Desert, Cheney, 1893. RUSK: no locality, Denniston, 1921 (D). ADAMS: Wisconsin Dells, A. M. Fuller, 1922 (D). DOUGLAS: Pattison Park, Denniston, 1935 (D).

3. *Cladonia mitis* Sandst. On sandy soil, hill tops and in bogs. BURNETT: Danbury, Wm. O'Gara, 1937; Web Lake, 1937. JUNEAU: Wisconsin Dells, 1935; Necedah,

1936. WAUSHARA: Plainfield, 1935. SAUK: Spring Green, 1935. MONROE: Warrens, 1937. MARINETTE: Amberg, 1937. SAWYER: Seeley, Newton T. Bobb, 1929. WASHBURN: Minong, Denniston, 1920 (D). ONEIDA: Tomahawk Lake, 1941. In addition to the above collections, f. *setigera* with bristle-like outgrowths has been collected in Wisconsin.

Cladonia mitis f. *setigera* Sandst. FOREST: Argonne, 1937 (Y). ONEIDA: Tomahawk Lake, 1941. BURNETT: Web Lake, 1937.

4. *Cladonia alpestris* (L.) Rabenh. On soil, on hill tops and in open woods. ONEIDA: Newbold, Cheney, 1893; Tomahawk Lake, 1941. VILAS: Lac Vieux Desert, Cheney, 1893; Trout Lake, 1938. The compact, rounded masses in which this species grows are markedly different from the irregular entanglement of the other species of Cladinae or "Reindeer Mosses." It has a mild taste and is particularly useful fodder for reindeer. Its range is probably confined to the northern part of this state.

5. *Cladonia papillaria* (Ehrh.) Hoffm. The only collection made in Wisconsin is of f. *molariformis* with simple to sparingly branched podetia. Fink reports this species westward to Ohio so that this is a notable extension of range.

Cladonia papillaria f. *molariformis* (Hoffm.) Schaer. On sandy soil on hill top. JUNEAU: Twin Bluffs west of New Lisbon, 1936.

6. *Cladonia Floerkeana* (Fr.) Floerke On earth, rocks, and old logs. As already stated, this species has been cited by Vainio from this state. The esquamulose var. *intermedia* has been recently collected.

Cladonia Floerkeana var. *intermedia* Hepp. ONEIDA: Tomahawk Lake, 1941.

7. *Cladonia bacillaris* (Ach.) Nyl. On earth, rotting logs, and over rocks. SAUK: Spring Green, 1936. JUNEAU: Necedah, 1936; Camp Douglas, 1936; Lyndon Station, 1938; New Lisbon, 1937 (Y). JEFFERSON: Hope Lake bog, 1936. BURNETT: Web Lake, 1937. BAYFIELD: Eliot, 1937. DANE: Mazomanie, 1937. WALWORTH: Lake Geneva, 1940. ONEIDA: Tomahawk Lake, 1941. The three forms found in Wisconsin are f. *clavata* which shows a negative reaction with KOH and is blunt, sterile or with terminal apothecia; f. *peritheta*, KOH —, and with accesory apothecia on lateral branches; and f. *reagens* with yellowish-brown patches which turn violet with KOH.

Cladonia bacillaris f. *clavata* (Ach.) Vainio. JEFFERSON: Hope Lake bog, 1936. SAUK: Spring Green, 1936. FOREST: Argonne, 1937. PORTAGE: Stevens Point, 1938. VILAS: Sayner, 1938. WALWORTH: Lake Geneva, 1941.

Cladonia bacillaris f. *peritheta* (Wallr.) Arn. ONEIDA: Monico, 1937. JUNEAU: Mauston, 1936. PORTAGE: Stevens Point, 1938.

Cladonia bacillaris f. *reagens* Evans. DANE: Madison, Heald and Buell, 1893.

8. *Cladonia macilenta* Hoffm. On earth and over rocks. Two forms have been collected in Wisconsin; f. *styracella* with farinose soredia and *f. granulosa* with granulose soredia.

Cladonia macilenta f. *granulosa* Aigret. PORTAGE: Stevens Point, 1938.

Cladonia macilenta f. *styracella* (Ach.) Vainio. BAYFIELD: Washburn, 1937.

9. *Cladonia didyma* (Fee) Vainio. On logs in tamarack bog. Only the decorticate, pointed, esquamulose form, f. *subulata*, has been thus far collected in Wisconsin.

Cladonia didyma f. *subulata* Sandst. WALWORTH: Lake Geneva, 1940.

10. *Cladonia pleurota* (Floerke) Schaer. On soil in open fields and woods. ADAMS: Wisconsin Dells, Cheney, 1894. JUNEAU: Necedah, Cheney, 1894. VILAS: Eagle River, Cheney, 1893. DANE: Mazomanie, M. P. Backus, 1938. IOWA: Ridgeway, Denniston, 1924 (D). SAUK: Spring Green, 1939.

11. *Cladonia digitata* Hoffm. On rotting logs. VILAS: Trout Lake, 1938; Conover, Cheney, 1893; Sayner, 1941. SAUK: Devil's Lake, 1936. MARATHON: Rib Falls, 1938. ONEIDA: Tomahawk Lake, 1941.

12. *Cladonia cristatella* Tuck. On rotting logs, stumps, earth, and on rocks. Very common on the sandy soils of central Wisconsin. The forms collected thus far in this state may be distinguished as follows:

Apothecia scarlet.

Apothecia sessile on the primary squamules or short stalked. .....*f. abbreviata*
Apothecia on distinct podetia.
Podetia squamulose.
Apothecia terminal or on main branches. .....f. *vestita*
Apothecia on short stalks or sessile on the side of the podetia.....f. *pleurocarpa*
Podetia lacking sqamules.
Podetia simple or sparingly branched. .....f. *Beauvoisii*
Podetia abundantly branched. .....*f. ramosa*
Apothecia yellow to flesh colored. .....*f. ochrocarpia*

Cladonia cristatella f. *abbreviata* Merrill. SAUK: Spring Green, 1936.

Cladonia cristatella f. *Beauvoisii* (Del.) Vainio. WAUSHARA: Plainfield, 1935. ONEIDA: Tomahawk Lake, Cheney, 1893; Tomahawk Lake, 1941. MARATHON: Granite Heights, Cheney, 1893. JUNEAU: Necedah, Cheney, 1894; Mather, 1936. MARINETTE: Thunder Mt., 1937; Crivitz, 1937; Peshtigo, 1937. OCONTO: Stiles, 1937. ASHLAND: Mellen, L. R. Wilson, 1927 (D). VILAS: Sayner, 1941.

Cladonia cristatella f. *ochrocarpia* Tuck. ONEIDA: Monico, 1937. SAUK: Spring Green, 1939.

Cladonia cristatella f. *pleurocarpa* Robbins. WASHBURN: Madge, R. I. Evans, 1939.

Cladonia cristatella f. *ramosa* Tuck. MARQUETTE: Westfield, 1935. ADAMS: Wisconsin Dells, A. M. Fuller, 1922 (D). BURNETT: Swiss Bridge, L. R. Wilson, 1927 (D). DANE: Mazomanie, Denniston, 1925 (D). WASHBURN: Minong, Denniston, 1920 (D). SAUK: Ableman, 1940. ONEIDA: Tomahawk Lake, 1941.

Cladonia cristatella f. *vestita* Tuck. SAUK: Spring Green, 1935, 1936; Devil's Lake 1935; Leland, Denniston, 1935 (D); Devil's Lake, Denniston, 1920 (D). WAUSHARA: Plainfield, 1935; Red Granite, 1937. MONROE: Tomah, 1935. MARQUETTE: Westfield, 1935; Montello, 1937. DOUGLAS: Solon Springs, R. M. Reeve, 1936. JEFFERSON: Hope Lake bog, 1936. JUNEAU: Necedah, 1936, 1938; Necedah, Cheney, 1894; Mather, 1936. DANE: Mazomanie, 1937; Madison, Heald and Buell, 1893; Blue Mounds, H. W. Rickett, 1922 (D). ONEIDA: Tomahawk Lake, Cheney, 1893; Newbold, Cheney, 1893; Monico, 1937. MARATHON: Granite Heights, Cheney, 1893; Rib Falls, 1938. WOOD: Wisconsin Rapids, Cheney, 1894; Goodrich, Cheney, 1894. BAYFIELD: Bingo, 1937; Eliot, 1937; Washburn, 1937. WASHBURN: Spooner, 1937. FOREST: Argonne, 1937. COLUMBIA: Lodi, 1937. MARINETTE: Thunder Mt., 1937; Crivitz, 1937; Peshtigo, 1937. BROWN: Suamico, 1937. GREEN LAKE: Marquette, L. H. Shinners, 1938. SHAWANO: Keshena, R. Deckert, 1938. LINCOLN: Rainbow Rapids, Cheney, 1893. SHEBOYGAN: Hilton, C. C. Cooke, 1939. PORTAGE: Stevens Point, 1938. IOWA: Arena, Denniston, 1922 (D); Hollandale, Denniston, 1925 (D). ASHLAND: Butternut, Denniston, 1922 (D). ADAMS: Roche a cri, Denniston, 1935 (D).

13. *Cladonia incrassata* Floerke. On rotten wood. SAUK: Baraboo (Baxter's Hollow), 1939. WALWORTH: Lake Geneva, 1940. Both specimens were determined by Dr. Evans. One doubtful collection from Minnesota was reported by Bruce Fink in "Lichens of Minnesota." In "Lichens of the United States" the range of this species is reported as being "New England southward to Virginia."

14. *Cladonia uncialis* (L.) Web. On soil in open fields and exposed rocky ledges. JUNEAU: Necedah, 1936; Pedanwell Rock (Necedah), Cheney, 1894; New Lisbon, 1936. SAUK: Parfrey's Glen, Denniston, 1935 (D); Devil's Lake, 1936. MARINETTE: Amberg, 1937. In addition to the above collections which are typical for the species, specimens with slender axes and long terminal branches tipped with blackish fibrils, referred to f. *setigera*, and specimens with dilated axils often surrounded by fibrils, referred to f. *subobtusata*, have been collected. An analysis of the differences between *C. uncialis*, *C. caroliniana* and *C. Boryi* is given by A. W. Evans in Rhodora 34: 130-142.

Cladonia uncialis f. *setigera* Anders. IOWA: Ridgeway, Denniston, 1924 (D).
Cladonia uncialis f. *subobtusata* Coem. ONEIDA: Tomahawk Lake, 1941.

15. *Cladonia caroliniana* (Schwein.) Tuck. On sandy soil. IOWA: Hollandale, Denniston, 1925 (D). Two forms have been collected in this state; f. *dilatata* with irregularly dilated podetia and wartlike outgrowths in the upper parts; and f. *prolifera* in which the podetia are decumbent and more or less numerous outgrowths appear as a response to suppression of the apical growth.

Cladonia caroliniana f. *dilatata* Evans. SAUK: Spring Green, 1936. ADAMS: White Creek, 1938.

Cladonia caroliniana f. *prolifera* Evans. GREEN LAKE: Marquette, L. H. Shinners, 1938.

16. *Cladonia amaurocraea* (Floerke) Schaer. On quartzite talus slopes. The specimen collected at Devil's Lake is f. *oxyclada* with subulate podetial tips.

Cladonia amaurocraea f. *oxyclada* Vainio. SAUK: Devil's Lake, 1936.

17. *Cladonia furcata* (Huds.) Schrad. Reported from Wisconsin by Tuckerman. This species is represented by only one specimen from Wisconsin although it has been reported from Minnesota, Iowa, Illinois and Upper Michigan. It is undoubtedly more frequent than this sole specimen would indicate and should be sought in the northern part of the state. According to Dr. Sandstede the Wisconsin collection is of f. *abbreviata*.

Cladonia furcata f. *abbreviata* Scribe. MARINETTE: Amberg, 1937 (Y).

18. *Cladonia scabriuscula* (Del.) Leight. ASHLAND: Penokee Iron Range, I. A. Lapham, 1858. ONEIDA: McNaughton, Cheney, 1893.

19. *Cladonia multiformis* Merrill. On earth. DOUGLAS: no locality, Denniston, 1930 (D). Three forms have been collected in Wisconsin. They may be distinguished as follows: two forms have abundant cups, f. *Finkii* has the ultimate proliferations irregularly cylindrical, f. *simulata* has the ultimate proliferations forming small cups; the third form, f. *subascypha*, produces cups sparingly and these are often broken up into branches.

Cladonia multiformis f. *Finkii* (Vainio) Evans. BURNETT: Danbury, Wm. O'Gara, 1937. FOREST: Argonne, 1937. MARINETTE: Loomis, 1937. BAYFIELD: Lake Wiehe, Eliot, 1937 (Y). VILAS: Sayner, 1938, 1941.

Cladonia multiformis f. *simulata* Robbins. MARINETTE: Loomis, 1937; Amberg, 1937 (Y). VILAS: Sayner, 1941.

Cladonia multiformis f. *subascypha* (Vainio) Evans. VILAS: Sayner, 1938. PORTAGE: Stevens Point, 1938.

20. *Cladonia crispata* (Ach.) Flot. This species is cited by Vainio, "Wisconsin (leg. Greene)." On soil, rotting logs and over rocks. A collection in the herbarium of the University of Wisconsin is of f. *infundibulifera* with open cups and a persistent cortex.

Cladonia crispata f. *infundibulifera* (Schaer) Vainio. VILAS: Sayner, 1941.

21. *Cladonia squamosa* (Scop.) Hoffm. SAUK: Devil's Lake, 1936; Parfrey's Glen, 1936. MARINETTE: Thunder Mt., 1937. MARATHON: Granite Heights, Cheney, 1894. LINCOLN: no locality, Cheney, 1893. ONEIDA: Tomahawk Lake, Cheney, 1893. OCONTO: Little Suamico, 1937. PORTAGE: Stevens Point, 1938. Many forms of this variable species have been described. In addition to the above specimens which have not been assigned to any form, specimens representing four forms have been collected in Wisconsin. They are all cup-bearing forms: f. *phyllocoma* is corticate throughout, f. *denticollis* is decorticate above and naked or sparingly squamulose, f. *squamosissima* is decorticate above and densely squamulose, f. *phyllopoda* has a persistent, well developed primary thallus with poorly developed variable podetia, either cup-forming or subulate, only 2-8 mm. high.

Cladonia squamosa f. *denticollis* (Hoffm.) Floerke. LINCOLN: Rainbow Rapids, Cheney, 1893. ONEIDA: Newbold, Cheney, 1893. MARATHON: Granite Heights, Cheney, 1894. BARRON: Cheney, 1930. FOREST: Argonne, 1937. MARINETTE: Amberg, 1937. BURNETT: Swiss Bridge, L. R. Wilson, 1927 (D). VILAS: Sayner, 1941.

Cladonia squamosa f. *squamosissima* Floerke. MARINETTE: Amberg, 1937. SAUK: Baraboo, 1939; Devil's Lake, 1936. JUNEAU: New Lisbon, 1936. MONROE: Millston, 1937. VILAS: Trout Lake, 1938.

Cladonia squamosa f. *phyllocoma* (Rabenh.) Vainio. ADAMS: Wisconsin Dells, A. M. Fuller, 1922 (D).

Cladonia squamosa f. *phyllopoda* Vainio. SAUK: Parfrey's Glen, 1937 (Y).

22. *Cladonia cenotea* (Ach.) Schaer. On rotting logs and stumps. The podetia in var. *crossota* which represents this species in Wisconsin are short, commonly branched, and the cups are well developed.

Cladonia cenotea var. *crossota* (Ach.) Nyl. ONEIDA: Monico, 1937. VILAS: Trout Lake, 1938.

23. *Cladonia delicata* (Ehrh.) Floerke. On rotting logs and stumps. Represented in Wisconsin by f. *quercina* with granular soredia and small squamules on the podetia.

Cladonia delicata f. *quercina* (Pers.) Vainio. VILAS: Lac Vieux Desert, Cheney, 1893.

24. *Cladonia caespiticia* (Pers.) Floerke. On earth, rocks, and old wood. MONROE: Tomah, 1935. OCONTO: Little Suamico, 1937. PORTAGE: Stevens Point, 1938. MARATHON: Rib Falls, 1938. LAFAYETTE: Fayette, Cheney, 1894. VILAS: Trout Lake, 1938.

25. *Cladonia apodocarpa* Robbins. On earth. SAUK: Devil's Lake, 1935; Parfrey's Glen, 1936. Previously reported only in the east from Quebec to Virginia and in Kentucky.

26. *Cladonia turgida* (Ehrh.) Hoffm. On earth. Two forms of this species have been collected in Wisconsin; f. *corniculata*, cupless and esquamulose, and f. *scyphifera* which is cup-forming.

Cladonia turgida f. *corniculata* Floerke. BAYFIELD: Eliot, 1937.

Cladonia turgida f. *scyphifera* Vainio. FOREST: Argonne, 1937. VILAS: Sayner, 1941.

27. *Cladonia mitrula* Tuck. On earth and wood. Four forms occur in Wisconsin; f. *abbreviata* with podetia 0.5 to 5 mm. long, f. *imbricatula* with podetia 10 to 20 mm. tall and brown fruited, f. *pallida*, similar to the last but with pale flesh-colored apothecia, and *f. squamulosa*, distinguished by the squamules on the podetia. Additional specimens may also be among those cited under *C. cariosa*.

Cladonia mitrula f. *abbreviata* Vainio. SAUK: Spring Green, 1939.

Cladonia mitrula f. *imbricatula* (Nyl.) Vainio. WAUSHARA: Plainfield, 1935. FOND DU LAC: Ripon, 1935. SAUK: Spring Green, 1936; Baxter's Hollow, 1939. PORTAGE: Wisconsin Rapids, Cheney, 1894; Stevens Point, 1938. BROWN: Suamico, 1937. DANE: Mazomanie, 1937; Middleton, L. H. Shinners, 1939. JUNEAU: Necedah, 1938. COLUMBIA: Opposite Prairie du Sac, 1939. MONROE: no locality, Denniston, 1922 (D). IOWA: Arena, Denniston, 1922 (D); Hollandale, Denniston, 1925 (D).

Cladonia mitrula f. *pallida* Robbins. DANE: Mazomanie, 1935. SAUK: Ableman, 1941.

Cladonia mitrula f. *squamulosa* Merrill. WALWORTH: Williams Bay, 1940. This form was previously reported only from New Jersey and West Virginia.

28. *Cladonia clavulifera* Vainio. On earth. Only the typical form, *f. nudicaulis*, with esquamulose club-shaped podetia has been collected in Wisconsin.

Cladonia clavulifera f. *nudicaulis* Evans. WASHBURN: Spooner, 1937. JUNEAU: Mather, 1936.

29. *Cladonia cariosa* (Ach.) Spreng. On earth and old wood. ONEIDA: Newbold, Cheney, 1893; Monico, 1937; McNaughton, Cheney, 1893. BAYFIELD: Lenawee, 1937, Bingo, 1937. MARINETTE: Loomis, 1937; Amberg, 1937. IRON: Hurley, 1937. DANE: Black Earth, E. L. Fisk, 1924 (D). These specimens are tentatively placed under this

species although Dr. Evans says (in a letter) of those which he has examined: "Your specimens of 'C. *cariosa*' are very puzzling and all ——, from a morphological standpoint, look like my European material of this species. Your No. 1567 (Newbold, Cheney, 1893), for example, is very similar to Sandstede's No. 1619 from Switzerland. I find, however, that No. 1567 is definitely P + and that the same thing is true of Nos. 42, 554, and 490 (Lenawee, 1937; Hurley, 1937; Monico, 1937), although the reaction in the last is slow and rather faint. The P + reaction is a characteristic of *C. mitrula*, whereas *C. cariosa* is said to be uniformly P —. According to this criterion your four packets represent *C. mitrula* and I should refer them all to f. *imbricatula*." Dr. Evans determined other material as being f. *cribrosa*. This form has the podetia well developed and the cortex well dispersed.

Cladonia cariosa f. *cribrosa* (Wallr.) Vainio. VILAS: Sayner, 1941.

30. *Cladonia subcariosa* Nyl. On earth. SAUK: Spring Green, 1935; Parfrey's Glen, 1936. JUNEAU: Camp Douglas, 1936; Necedah, 1938. ONEIDA: Monico, 1937 (Y). BAYFIELD: Bayfield, 1937 (Y). MARINETTE: Crivitz, 1937.

31. *Cladonia Norrlini* Vainio. On an old stump in a pastured alder swamp. DANE: Mazomanie, 1935.

32. *Cladonia decorticata* (Floerke.) Spreng. On old wood. ONEIDA: Tomahawk Lake, 1941.

33. *Cladonia gracilis* (L.) Willd. On moist earth. All specimens thus far collected in Wisconsin have the stout, cup-bearing podetia characteristic of var. *dilatata*. Specimens with regular cups bearing apothecia are identified as f. *anthocephala;* those with very irregular, often oblique cups with deep marginal indentations are f. *dilacerata*. One specimen with abortive apothecia or spermagonia forming continuous thickened bands along the margins of the cups is identified as f. *floripara* by Dr. A. W. Evans.

Cladonia gracilis var. *dilatata* (Hoffm.) Vainio. MARINETTE: Thunder Mt., 1937; Loomis, 1937; Amberg, 1937. BAYFIELD: Lenawee, 1937. MONROE: Millston, 1937. ASHLAND: Penokee Iron Range, I. A. Lapham, 1858; Mellen, Denniston, 1927 (D). VILAS: Lac Vieux Desert, Cheney 1893; Sayner, 1938, 1941. PORTAGE: Stevens Point, 1938. WASHBURN: Seymour Lake, R. I. Evans, 1939. SAUK: Devil's Lake, Denniston, 1922 (D). RUSK: no locality, Denniston, 1921 (D). ONEIDA: Tomahawk Lake, 1941.

Cladonia gracilis var. *dilatata* f. *anthocephala* (Floerke) Vainio. VILAS: Conover, Cheney, 1893; Sayner, 1941. PORTAGE: no locality, Cheney, 1894. MARATHON: Mosinee, Cheney, 1894. OCONTO: Little Suamico, 1937.

Cladonia gracilis var. *dilatata* f. *dilacerata* (Floerke) Vainio. IRON: Hurley, 1937. BARRON: Barron, Cheney, 1930. ONEIDA: McNaughton, Cheney, 1893.

Cladonia gracilis var. *dilatata* f. *floripara* (Floerke) Sandst. VILAS: Lac Vieux Desert, Cheney, 1893.

34. *Cladonia verticillata* (Hoffm.) Schaer. On earth. JUNEAU: Germantown, Cheney, 1894. VILAS: Sayner, 1938. SAUK: Devil's Lake, Denniston, 1922 (D); Ableman, 1940, 1941. BURNETT: Swiss Bridge, Denniston, 1927 (D). ADAMS: Wisconsin Dells, A. M. Fuller, 1922 (D). Four forms have been collected in Wisconsin: f. *evoluta* has single cup-bearing proliferations in the center of each rank of cups; f. *aggregata* has numerous closely packed proliferations from the upper surface of the cups; f. *apoticta* has marginal as well as central proliferations; and f. *phyllocephala* which differs from the preceding forms in being more or less squamulose.

Cladonia verticillata f. *aggregata* (Del.) Oliv. SAUK: Devil's Lake, 1935.

Cladonia verticillata f. *apoticta* (Ach.) Vainio. SAUK: Spring Green, 1936. JUNEAU: Camp Douglas, 1936.

Cladonia verticillata f. *evoluta* (Th. Fr.) Stein. WAUSHARA: Plainfield, 1935. MARQUETTE: Westfield, 1935; Montello, 1937. ADAMS: Leola, 1935. DOUGLAS: Solon Springs, R. M. Reeve, 1936. DANE: Mazomanie, 1937. MARINETTE: Crivitz, 1937;

Amberg, 1937; Loomis, 1937; Peshtigo, 1937. JUNEAU: Mather, 1936; Necedah, 1936, 1938; Germantown, Cheney, 1894. BAYFIELD: Bingo, 1937; Lenawee, 1937. OCONTO: Stiles, 1937. BROWN: Suamico, 1937. FOREST: Argonne, 1937. VILAS: Trout Lake, 1937; Sayner, 1941. ONEIDA: Tomahawk Lake, Cheney, 1893; Newbold, Cheney, 1893; Monico, 1937. MARATHON: Granite Heights, Cheney, 1894. SHAWANO: Keshena, R. A. Deckert, 1938. PORTAGE: Stevens Point, 1938.

Cladonia verticillata f. *phyllocephala* (Flot.) Oliv. SAUK: Devil's Lake, 1935 (Y).

35. *Cladonia pyxidata* (L.) Hoffm. On earth. SAUK: Devil's Lake, Denniston, 1920 (D). In addition to the above collection, not assigned to a form, specimens with free and ascending primary squamules, var. *neglecta*, and others with squamulose podetia, f. *lophyra*, have been collected in Wisconsin.

Cladonia pyxidata var. *neglecta* (Floerke) Mass. VILAS: Sayner, 1941.

Cladonia pyxidata var. *neglecta* f. *lophyra* (Ach.) Koerb. ADAMS: White Creek, 1938.

36. *Cladonia chlorophaea* (Floerke) Spreng. On earth, tree bases and old wood. Specimens collected in Wisconsin have been referred to three forms: f. *carpophora* which is fertile, and *f. simplex* and f. *conistea* both of which are sterile.

Cladonia chlorophaea f. *carpophora* (Floerke) Anders. WAUSHARA: Plainfield, 1935. SAUK: Devil's Lake, 1935; Spring Green, 1936. JUNEAU: Germantown, Cheney, 1894. OCONTO: Little Suamico, 1937. FOREST: Argonne, 1937. VILAS: Sayner, 1938, Winchester, Chas. McGraw, 1935. IOWA: Tower Hill, 1939; Hollandale, Denniston, 1925 (D). WALWORTH: Lake Geneva, 1940.

Cladonia chlorophaea f. *conistea* Del. DANE: Mazomanie, 1935.

Cladonia chlorophaea f. *simplex* (Hoffm.) Arn. BURNETT: Danbury, Wm. O'Gara, 1937. ADAMS: Leola, 1935; Friendship, 1935. MONROE: Tomah, 1935. WAUSHARA: Plainfield, 1935. FOND DU LAC: Ripon, 1935. SAUK: Devil's Lake, 1935; Spring Green, 1936; Parfrey's Glen, 1936; Baraboo, 1939; Ableman, 1941. MARQUETTE: Westfield, 1935. JUNEAU: Necedah, 1936, 1938; Camp Douglas, 1936; Mauston, 1936; Mauston, L. R. Wilson, 1931 (D). JEFFERSON: Hope Lake Bog, 1936. IRON: Hurley, 1937. COLUMBIA: opposite Prairie du Sac, 1935; Lodi, 1937. DANE: Mazomanie, 1937; Madison, Heald and Buell, 1893; Pine Bluff, 1937; Madison, L. H. Shinners, 1939. MARINETTE: Crivitz, 1937; Amberg, 1937; Peshtigo, 1937. TAYLOR: Goodrich, Cheney, 1894. ONEIDA: Monico, 1937; Tomahawk Lake, 1941. OCONTO: Little Suamico, 1937. FOREST: Argonne, 1937. BROWN: Suamico, 1937. VILAS: Sayner, 1938; Trout Lake, 1938. PORTAGE: Custer, 1938; Stevens Point, 1938. MARATHON: Rib Falls, 1938. WASHBURN: Madge, R. I. Evans, 1939. RUSK: Ladysmith, Denniston, 1921 (D). IOWA: Arena, Denniston, 1922 (D); Hollandale, Denniston, 1925 (D). ASHLAND: Butternut, Denniston, 1925 (D). WALWORTH: Lake Geneva, 1940.

37. *Cladonia Grayi* Merrill. On earth, tree bases and old wood. Two forms, f. *carpophora*, fertile, and f. *simplex*, sterile, analogous forms to those in *C. chlorophaea*, have been collected in Wisconsin. A third form, negative in reaction with paraphenylenediamine but lacking grayanic acid, called *f. aberrans* by Asahina, has been determined by Dr. Evans in material sent him. According to Sandstede's book (Evans, in letter) this would be placed in *C. chlorophaea*.

Cladonia Grayi f. *carpophora* Evans. JUNEAU: New Lisbon, 1936.

Cladonia Grayi f. *simplex* Robbins. WASHBURN: Madge, R. E. Evans, 1939. IOWA: Hollandale, Denniston, 1925 (D).

Cladonia Grayi f. *aberrans* Asahina. WALWORTH: Lake Geneva, 1941.

38. *Cladonia conista* (Ach.) Robbins. Only sterile material representing f. *simplex* has thus far been collected in Wisconsin.

Cladonia conista f. *simplex* Robbins. WALWORTH: Whitewater, 1940. VILAS: Sayner, 1941.

39. *Cladonia fimbriata* (L.) Fr. On earth and old wood. FOREST: Three Lakes,

H. Wolf, 1938. JUNEAU: Lyndon Station, 1938. ONEIDA: Monico, 1937. BAYFIELD: Lenawee, 1937. VILAS: Sayner, 1938, 1941. BURNETT: no locality, Denniston, 1927 (D). ADAMS: Roche a cri, Denniston, 1935 (D). ASHLAND: Mellen, L. R. Wilson, 1927 (D).

40. *Cladonia major* (Hag.) Sandst. On earth. PORTAGE: Stevens Point, 1938. VILAS: Eagle River, Cheney, 1893; Sayner, 1941.

41. *Cladonia nemoxyna* (Ach.) Nyl. On earth. SAUK: Spring Green, 1935; Ableman, 1941. DOUGLAS: Solon Springs, R. M. Reeve, 1936. MARINETTE: Crivitz, 1937; Loomis, 1937; Amberg, 1937; Peshtigo, 1937. OCONTO: Stiles, 1937. WASHBURN: Spooner, 1937; Madge, R. I. Evans, 1939. MARQUETTE: Montello, 1937. MARATHON: Rib Falls, 1938. JUNEAU: Necedah, 1936, 1938; Mauston, 1936. VILAS: Sayner, 1938, 1941. DANE: Mazomanie, 1937. MONROE: Millston, 1937. BROWN: Suamico, 1937. FOREST: Argonne, 1937. PORTAGE: Stevens Point, 1938. POLK: Lewis, J. J. Davis, 1924 (D).

42. *Cladonia cornuta* (L.) Schaer. Reported from Wisconsin by Vainio "ad tamarack in Wisconsin (Lapham)." It was also reported by Tuckerman but no specimens are in the herbarium of the University of Wisconsin and it has not been recently collected.

43. *Cladonia coniocraea* (Floerke) Spreng. On earth and old wood. WAUSHARA: Plainfield, 1935. The three forms collected in Wisconsin may be distinguished as follows: f. *ceratodes* has slender podetia which taper gradually to points, f. *truncata* has narrow cups or conspicuous depressions at the tips of the podetia, f. *robustior* is pointed like f. *ceratodes* but the podetia are stouter, up to 2.5-3 mm. in diameter.

Cladonia coniocraea f. *ceratodes* (Floerke) Dalla. WASHINGTON: Kekoshee, 1936. SAUK: Spring Green, 1936; Parfrey's Glen, 1936. JEFFERSON: Hope Lake bog, 1936. DANE: Mazomanie, 1937. ONEIDA: Tomahawk Lake, Cheney, 1893; Monico, 1937; Tomahawk Lake, 1941. VILAS: Conover, Cheney, 1893; Trout Lake, 1937; Land O'Lakes, R. I. Evans, 1939. MARATHON: Rib Falls, 1938. Portage: Stevens Point, 1938. OCONTO: Little Suamico, 1937. MARINETTE: Peshtigo, 1937. WALWORTH: Whitewater, 1940.

Cladonia coniocraea f. *robustior* (Harn.) Sandst. MARINETTE: Thunder Mt., 1937. ONEIDA: Tomahawk Lake, 1941.

Cladonia coniocraea f. *truncata* (Floerke) Dalla. VILAS: Conover, Cheney, 1893; Trout Lake, 1938. DANE: Mazomanie, 1937. OCONTO: Little Suamico, 1937. ONEIDA: Tomahawk Lake, 1941.

44. *Cladonia borbonica* (Del.) Nyl. On earth and old wood. The Wisconsin specimens are cupless, sharp pointed and without squamules, therefore are referred to f. *cylindrica*.

Cladonia borbonica f. *cylindrica* Evans. COLUMBIA: Lodi, 1937. DANE: Springfield Corners, 1938. VILAS: Trout Lake, 1938.

45. *Cladonia pityrea* (Floerke) Fr. On earth, bases of trees and old wood. Wisconsin specimens are short (var. *Zwackhii*) and sorediose; f. *subacuta* is nearly or almost without squamules and f. *squamulifera* is squamulose.

Cladonia pityrea var. *Zwackhii* Vainio f. *squamulifera* Vainio. SAUK: Spring Green, 1936. WALWORTH: Lake Geneva, 1940.

Cladonia pityrea var. *Zwackhii* f. *subacuta* Vainio. JEFFERSON: Hope Lake Bog, 1936. WAUSHARA: Red Granite, 1937. MARINETTE: Amberg, 1937; Thunder Mt., 1937. PORTAGE: Stevens Point, 1938. WALWORTH: Lake Geneva, 1940. VILAS: Sayner, 1941.

46. *Cladonia strepsilis* (Ach.) Vainio. On earth. BURNETT: Web Lake, 1937. OZAUKEE: Cedarburg, L. H. Shinners, 1938. In addition to the sterile specimens listed

above, specimens bearing well developed podetia and squamulose, f. *coralloidea*, or lacking squamules, f. *glabrata*, have been collected in Wisconsin.

Cladonia strepsilis f. *coralloidea* (Ach.) Vainio. SAUK: Spring Green, 1935.

Cladonia strepsilis f. *glabrata* Vainio. WAUSHARA: Plainfield, 1935.

47. *Cladonia botrytes* (Hag.) Willd. On old wood. MARATHON: Granite Heights, Cheney, 1894. FOREST: Argonne, 1937. BAYFIELD: Washburn, 1937. IRON: Hurley, 1937. ONEIDA: Tomahawk Lake, 1941.

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STATE TEACHERS COLLEGE,
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The Genus Hydrophyllum L.[1]

Lincoln Constance

The genus *Hydrophyllum* was originally proposed in 1659 by Morin, based upon plants now referred to *H. virginianum* L. Linnaeus recognized also *H. canadense*, and other species and varieties were proposed later by Michaux, Douglas, Nuttall, Rafinesque, Gray, Watson, Heller, and others. In important previous revisions, Bentham (1836) attributed 4 species to the genus, Gray (1875) recognized 6 species and 3 varieties, and Brand (1913) admitted 2 genera, 8 species, 6 varieties and 4 subvarieties. The present revision, which takes into account both field study and a large quantity of herbarium material unavailable to earlier workers, makes allowance for 8 species and 4 varieties.

Hydrophyllum appendiculatum Michx. has been referred by Brand, Small, and others to a distinct genus, *Decemium* Raf., chiefly because of its biennial habit, appendaged and markedly accrescent calyx and only slightly exserted stamens. Appendages rarely occur also on the calyx of *H. canadense*, and this character has proven to be somewhat unreliable in *Ellisia, Nemophila* and *Pholistoma* (Constance, 1939). The features of calyx accrescence and stamen exsertion are matters of degree, and the distinction between biennial and perennial growth does not seem sufficient, in itself, for the maintenance of a distinct genus. *Hydrophyllum appendiculatum* so closely resembles the other species in general aspect, in inflorescence, corolla, corolla scales, seeds and foliage, and in environmental preference and distribution, that it seems advisable to retain it within the genus.

All the species are characteristically mesophytic, many of them preferring shaded alluvial soil. No species completely departs from this environmental predilection, which would thus appear to be a physiological attribute of the genus. Even *Hydrophyllum capitatum* Dougl. and its varieties, which frequently inhabit arid formations, cling persistently to the shelter of shrubs or rocks, or at least to moist soil. With the exception of *H. appendiculatum*, which has a tap-root system, all the species possess a horizontal, often scaly, subterranean rhizome. This rootstock is greatly shortened in *H. capitatum*, in which species it gives rise to a fascicle of conspicuously fleshy, finger-like roots. Relatively large, pinnate or pinnately divided leaves occur in all species, although all but the early basal leaves of *H. canadense* and *H. appendiculatum* are more or less palmately veined and lobed or divided. It thus seems likely that pinnate leaves, characteristic of all other genera of the tribe *Hydrophylleae*, represent a primitive foliar condition in *Hydrophyllum*, as well. The inflorescence

1 The writer wishes to acknowledge the assistance which has been rendered him in connection with this and other research projects by the Work Projects Administration, OP. 65-1-08-91 (Unit B-10).

consists, in all cases, of a raceme-like or capitate cyme, and it is assumed that condensation of flowers into a head is a derived arrangement.

From the foregoing, it appears that if this genus has had a single progenitor, it must have had some such group of features as the following: a mesophytic herb, perennial from a horizontal rhizome, with large, pinnate or pinnately divided leaves, a lax, cymose inflorescence, exserted stamens and styles, and possibly an appendaged calyx. With this picture as a guide and taking into account geographical distribution, the writer believes that the closely related species, *H. virginianum* and *H. tenuipes* Heller may represent the slightest departure from the primitive condition.

One of the outstanding facts about the genus is the high degree of similarity among the species in floral and fruit characters, as is indicated by the accompanying figures (Plate 1). Most of the differential characters are necessarily those of pubescence or leaf-cutting (Plate 2), which may be either intangible or difficult to describe precisely, and often vary within rather wide limits. Although it is not difficult to learn to recognize all but an occasional specimen at a glance, the attempt to construct a workable key has met with considerable difficulty.

As indicated by the accompanying maps, the eight species are equally divided into two discrete groups, occupying, respectively, the eastern United States and neighboring Quebec and Ontario, and the western United States and adjacent Alberta and British Columbia, with a gap completely separating the two assemblages. The center of distribution of the eastern species lies in southern Illinois, Indiana and Ohio and northern Kentucky, just at the southern edge of maximum Pleistocene glaciation. The western species are somewhat more irregularly distributed than the eastern, but appear to center in the Klamath-Siskiyou area of southern Oregon and northern California. It is notable that both of these foci are in geologically ancient areas and may very well have served as "refugia" from which the modern species have been able to spread into their present ranges, which include extensively glaciated territory.

No one species occurs in both the eastern and western areas of the genus. However, the relationship between *H. virginianum* of the eastern group, and *H. tenuipes* of the Pacific Coast is extremely close, and it seems likely that if their ranges were not now completely separated they might still find opportunity to exchange genes. There are also indications of a less close affinity connecting *H. virginianum* and *H. tenuipes* with *H. Fendleri* (Gray) Heller, and between *H. macrophyllum* Nutt. and *H. occidentale* (Wats.) Gray. Whatever the degree of these relationships, they suggest that the eastern and western groups of species must have been connected at one time or another. It is difficult to know whether the present gap was bridged by a connection to the north, or whether the two present centers represent the remnants of a once widespread distribution over temperate North America, under the prevalence of less arid conditions than those prevailing today over much of the area. There is little to indicate that they have had an immediate origin from the south.

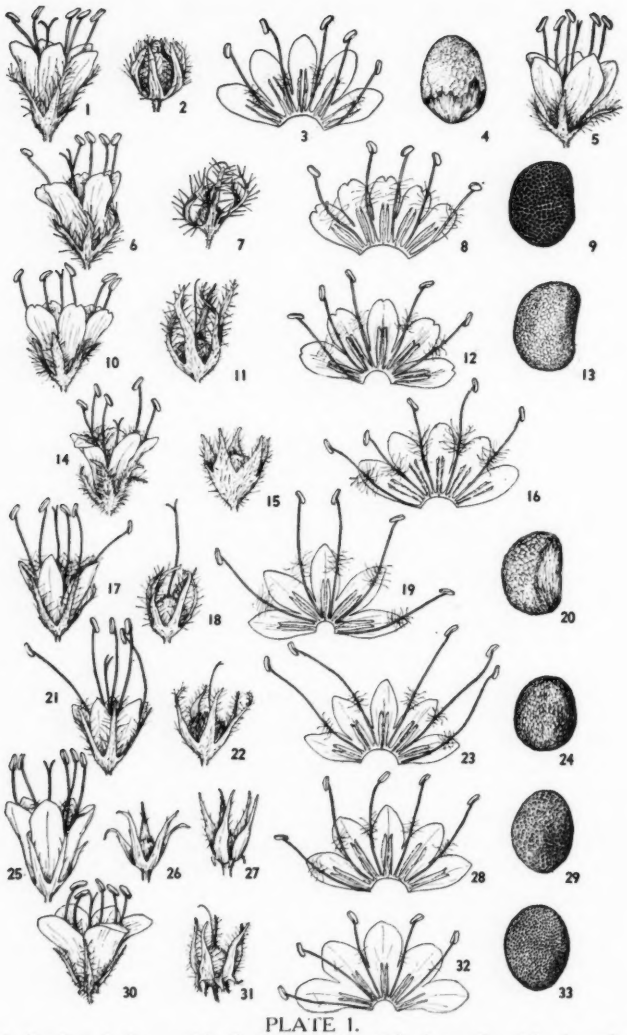


PLATE 1.

H. Fendleri. 1. flower ×1.5; 2. fruiting calyx ×1.5; 3. corolla ×1.5; 4. seed ×5.5. Var. *albifrons.* 5. flower ×1.5. *H. capitatum.* 6. flower ×1.5; 7. fruiting calyx ×1.5; 8. corolla ×1.5; 9. seed ×4.5. *H. occidentale.* 10. flower ×1; 11. fruiting calyx ×1; 12. corolla ×4.5; 13. seed ×4. *H. macrophyllum.* 14. flower ×1; 15. fruiting calyx ×1; 16. corolla ×1. *H. virginianum.* 17. flower ×1; 18. fruiting calyx ×1; 19. corolla ×1; 20. seed ×4.5. *H. tenuipes.* 21. flower ×1.5; 22. fruit ×1.5; 23. corolla ×1.5; 24. seed ×4. *H. canadense.* 25. flower ×1.5; 26, 27. fruiting calyces ×1.5; 28. corolla ×1; 29. seed ×4. *H. appendiculatum.* 30. flower ×1; 31. fruiting calyx ×1.5; 32. corolla ×1; 33. seed ×4.

Because the accompanying maps have been compiled upon the basis of all the collections examined, and all the authentic published records available, it seems superfluous to cite more than a few representative specimens of each species, preferably those numbers to be found in several herbaria. The space saved by omitting the customary designation of the herbaria in which the cited specimens are deposited, except in the case of types and some isotypes, has been utilized for the citation of additional collections. The writer wishes to acknowledge his indebtedness to the maps in Deam's, "Flora of Indiana" and Gates,' "Flora of Kansas," the distributional records for Pennsylvania kindly furnished by Dr. John M. Fogg, Jr., and the extensive collections from Missouri accumulated by Dr. Julian A. Steyermark.

Mr. J. H. Christ, Spokane; Mr. Ira W. Clokey, South Pasadena; Dr. W. L. Jepson, Berkeley, and Mr. J. W. Thompson, Seattle, have kindly permitted me to borrow the specimens of this genus in their personal collections. The curators of the following institutions have generously made available the material in their care: California Academy of Sciences; National Museum of Canada; Cornell University (CU); Dudley Herbarium, Stanford University; Field Museum of Natural History; Gray Herbarium, Harvard University (GH); Intermountain Herbarium, Utah State Agricultural College; Missouri Botanical Garden; University of Minnesota; Montana State University; New York Botanical Garden (NY); Pomona College; Academy of Natural Sciences, Philadelphia (PA); Rocky Mountain Herbarium, University of Wyoming; University of California; University of Idaho, Southern Branch; University of Oregon; United States National Herbarium; Willamette University, and State College of Washington (WS).

Taxonomic Treatment

HYDROPHYLLUM [Morin] L.

Hydrophyllum L. Sp. Pl. 146. 1753.

Erect, branched or simple herbs, perennial from horizontal rhizomes, bearing fleshy-fibrous or tuberous roots, or biennial from a tap root, bearing fibrous roots. Stems slightly succulent, angled or terete, pubescent or glabrate. Cotyledons oblong to oval, on petioles of about equal length, withered at anthesis. Leaves usually large, membranaceous, basal and alternate; the basal leaves oblong to suborbicular in outline, pinnately divided or pinnatifid, the lobes variously toothed, lobed or divided, pubescent to glabrate on both surfaces, sometimes deciduous before anthesis; cauline leaves like the basal, or orbicular to reniform, shallowly palmately lobed to divided. Petioles slightly dilated and connate-clasping at base, usually ciliate. Flowers several to many in terminal, lax to capitate, simple or branched cymes. Pedicels slender or short, often elongating and sometimes recurving in fruit. Calyces campanulate, divided to below the middle or nearly to the base into 5 entire lobes, the sinuses naked or each with a reflexed auricle which resembles a diminutive calyx lobe; lobes, and auricles if present, pubescent or glabrate on the outer and sometimes also on the inner surface, usually ciliate. Corollas greenish-white or white to purple or violet, plain or marked, campanulate to sub-pelviform, divided

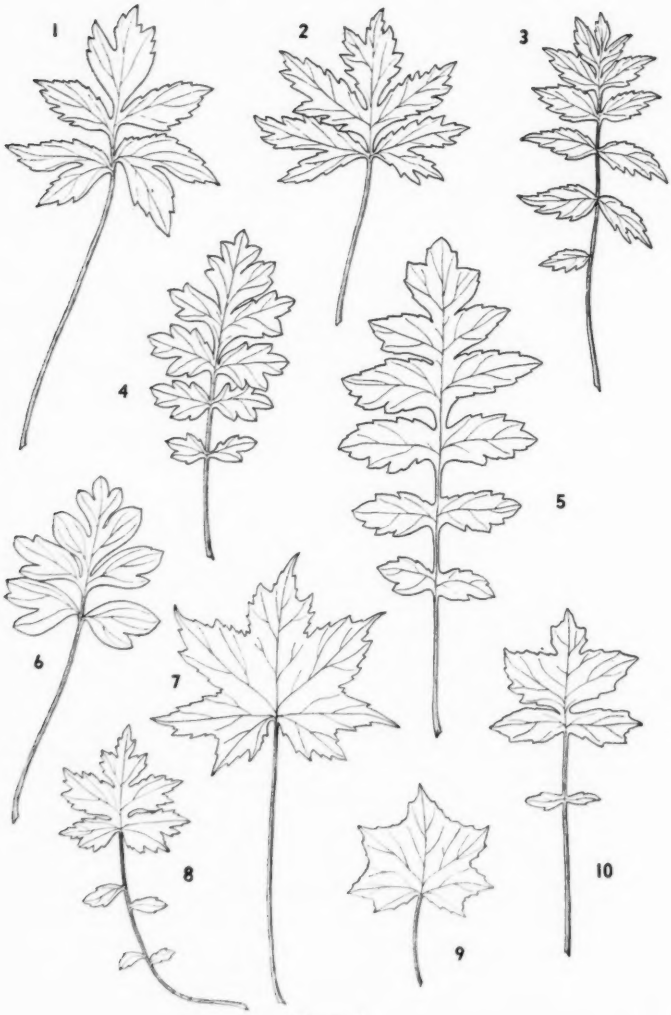


PLATE 2.

H. virginianum. 1. basal leaf. *H. tenuipes*. 2. lower cauline leaf. *H. Fendleri*. 3. lower cauline leaf. *H. occidentale*. 4. basal leaf. *H. macrophyllum*. 5. basal leaf. *H. capitatum*. 6. basal leaf. *H. canadense*. 7. cauline leaf; 8. basal leaf. *H. appendiculatum*. 9. cauline leaf; 10. basal leaf (All figures ×1/4.)

to the middle or below into 5 entire or retuse, distally pilose lobes, imbricate in aestivation, the whole corolla exceeding the calyx. Corolla scales linear, a pair bordering each filament, adnate to the corolla tube by one edge, the other ciliate. Stamens 5, exserted, the filaments more or less villous, rarely glabrate, at about the middle, the anthers oblong to linear. Pollen grains smooth, tricolpate. Style 1, exserted, cleft only 1-2 mm., the stigmas capitate. Mature capsule globose, 1-celled, hispid at the summit and often pubescent, in fruit loosely enclosed by the accrescent or non-accrescent calyx. Ovules borne on the front of the two large parietal placentae. Seeds 1-3, subglobose, reticulate, brown. Cucullus none.

Type species:—*H. virginianum* L.

KEY TO THE SPECIES AND VARIETIES

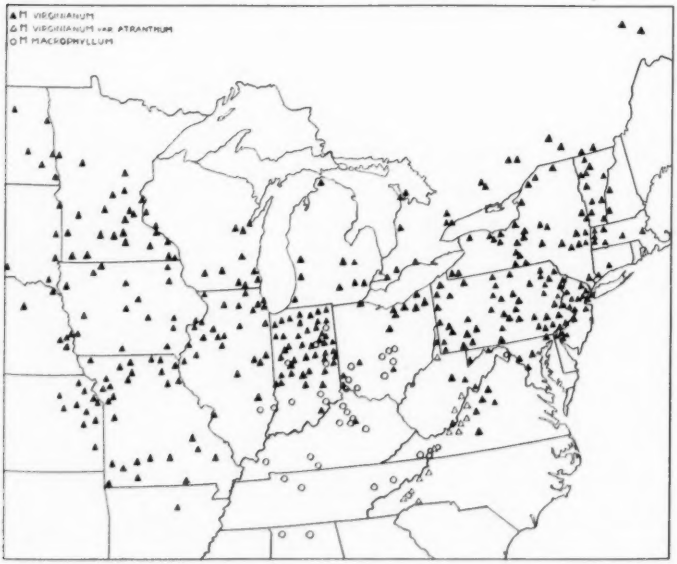
1. Perennial from horizontal rhizomes; calyx rarely and then minutely appendaged, weakly accrescent or non-accrescent in fruit; corolla broadly campanulate; stamens and styles usually exserted 5-10 mm. ..... [§ *Euhydrophyllum*].
2. Cauline leaves like the basal, oblong to suborbicular, pinnately parted or divided; stems usually manifestly pubescent.
3. Plants usually tall; rhizome conspicuous, often scaly, bearing fleshy-fibrous roots; anthers linear-oblong, 1-2 mm. long; leaflets variously cut to entire but usually toothed on the lower edge.
4. Leaves ovate to suborbicular, pinnately divided to somewhat pinnatifid, leaflets usually 5, occasionally 7-9; cymes lax in flower, the pedicels 3-12 mm. long.
5. Stems glabrate to strigose above; corolla 6-10 mm. long; seeds usually 2; plants of central and eastern North America.
6. Flowers white to lavendar or purple; plants of low elevations ..... 1. *H. virginianum*.
6. Flowers deep violet; plants of the southern Appalachian Mts. ..... 1a. *H. virginianum* var. *atranthum*.
5. Stems retrorse-hispid above, harsh to the touch; corolla 5-7 mm. long; seeds usually solitary; plants of the Pacific Coast ..... 2. *H. tenuipes*.
4. Leaves oblong to oblong-oval, pinnatifid, the leaflets 7-19; cymes subcapitate in flower, the pedicels 2-8 mm. long.
7. Leaflets acuminate, the teeth usually 8-12, acuminate; cymes lax in fruit.
8. Pubescence of the foliage harsh; calyx lobes sparsely hairy on the back, strongly hispid-ciliate; corollas 6-8 mm. long, only slightly exceeding the calyx ..... 3. *H. Fendleri*.
8. Pubescence of the foliage soft; calyx lobes abundantly soft-hairy on the back, weakly ciliate; corollas 7-10 mm. long, much exceeding the calyx ..... 3a. *H. Fendleri* var. *albifrons*.
7. Leaflets obtuse to abruptly acute, the teeth usually 3-6, obtuse to acute; cymes compact in fruit.
9. Calyx divided nearly to the base, the lobes abruptly acute; leaves usually soft-pubescent beneath; plants of the western United States ..... 4. *H. occidentale*.
9. Calyx divided one-half to two-thirds, the lobes acuminate; leaves harshly pubescent beneath; plants of the eastern and central United States ..... 5. *H. macrophyllum*.
3. Plants usually low; rhizome very short, bearing a fascicle of fleshy, finger-like roots; anthers short-oblong, 0.6-1 mm. long; leaflets entire or toothed, incised or divided only at apex, not toothed on the lower edge.
10. Cymes capitate even in fruit, the pedicels 2-5 mm. long; plants usually caulescent.

11. Peduncles 1-5 cm. long, conspicuously shorter than the subtending leaves, usually recurved in fruit .....6. *H. capitatum.*
11. Peduncles 5-20 cm. long, conspicuously longer than the subtending leaves, usually erect in fruit; plants of the Columbia River Gorge and vicinity .....6a. *H. capitatum* var. *Thompsoni.*
10. Cymes lax, at least in fruit, the pedicels 5-20 mm. long, reflexed or spreading in fruit; plants usually acaulescent or nearly so .....6b. *H. capitatum* var. *alpinum.*
2. Cauline leaves orbicular to reniform, palmately lobed or divided; stems usually glabrate, or nearly so .....7. *H. canadense.*
1. Biennial with a taproot bearing fibrous roots; calyx always conspicuously appendaged, strongly accrescent in fruit; corolla sub-pelviform; stamens and styles exserted only 1-3 mm. [§*Decemium*]. .....8. *H. appendiculatum.*

1. HYDROPHYLLUM VIRGINIANUM L.

Hydrophyllum virginianum L. Sp. Pl. 146. 1753.
Hydrophyllum virginicum L. Syst. ed. 12. 152. 1767.
Hydrophyllum pinnatifidum Moench, Meth. 428. 1794.
Hydrophyllum spiraeaefolium Salisb. Prodr. 120. 1796.
Hydrophyllum patens Britt. Torreya **2**: 123. 1902.
Hydrophyllum virginicum var. *patens* Brand, Pflanzenr. 251: 35. 1913.
Hydrophyllum virginianum f. *simplicifolium* Fern. Rhodora **40**: 341. *pl. 502.* 1938.

Plants 1-9 dm. high, the stems finely strigulose above, sparsely retrorse-hispid below or glabrate throughout, perennial from a scaly, elongated rhizome bearing fleshy-fibrous roots; leaves broadly ovate to oval in outline,



excluding the petiole 5-30 cm. long, 5-15 cm. broad, pinnately divided to somewhat pinnatifid, the principal divisions usually 5, occasionally 7-9, ovate-lanceolate to rhomboid-ovate, acuminate or acute, 2.5-11 cm. long, the lowest pair or pairs distinct, often deeply 2-parted, the terminal confluent, 3-cleft, all coarsely serrate to incised, the lobes acuminate, mucronate, strigulose above, pale and strigulose or glabrate beneath; petiole 5-25 cm. long, somewhat retrorse-hispid at least below; cauline leaves similar or broader; inflorescence of several lax cymes, the peduncles 2-20 cm. long, usually branched and exceeding the subtending leaves, strigulose above; pedicels 3-12 mm. long, spreading or reflexed, densely strigulose; calyx divided nearly to the base, the lobes linear to subulate, acute, 4-7 mm. long, 0.5-1.5 mm. broad, strigulose on the back, weakly hispid-ciliate, scarcely enlarging in fruit; corolla 6-10 mm. long, white to purple, the lobes oblong-oval, obtuse or retuse, 3-5 mm. long; stamens exserted 4-8 mm. beyond the corolla, the anthers linear-oblong, 1.5-2.5 mm. long; style exserted 5-10 mm., the ovary strigose, hispid at the summit; fruit 3-4 mm. in diameter; seeds usually 2, light brown, 2-3.5 mm. in diameter.

Type.—"Virginia," *(Clayton?)*.

Distribution.—Quebec and New England across the Great Lakes region to eastern North and South Dakota, south to Maryland, Virginia, Tennessee, northern Arkansas and eastern Kansas; at low altitudes.

Representative Specimens: QUEBEC. Outremont, Montreal, *Victorin & Germain 34,198*.—VERMONT. Charlotte, Chittenden Co., 1879, *Pringle* (GH, type of f. *simplicifolium*); Brattleboro, Windham Co., *Fernald & Harris (Pl. Exsic. Gray. 582)*.—MASSACHUSETTS. Pittsfield, Berkshire Co., 1865, *G. G. Kennedy*.—NEW YORK. Canton, St. Lawrence Co., *O. P. Phelps 790;* Stewart Park, Tompkins Co., *B. Maguire 6644*. ONTARIO. Aylmer, *R. T. Anderson 10,300*.—PENNSYLVANIA. Little Conestoga, Lancaster Co., 1901, *Heller;* Foster, Susquehanna Co., *L. F. & F. R. Randolph 9*.—DELAWARE. Newark, Newcastle Co., 1922, *H. B. Meredith*.—DISTRICT OF COLUMBIA. Chain Bridge, *S. F. Blake 9405*.—OHIO. Lancaster, Fairfield Co., *Bigelow;* Pittsfield, Lorain Co., 1894, *A. E. Ricksecker*.—KANSAS. Low woods, Leavenworth Co., *A. S. Hitchcock 766*.—MICHIGAN. Pellston, Emmet Co., *F. C. & M. T. Gates 10,506;* Ann Arbor, Washtenaw Co., *F. J. Hermann 6553*.—INDIANA. Indianapolis, Marion Co., *Friesner 5551, 8696;* Harrison Township, Wells Co., *Deam 1978*.—ILLINOIS. Naperville, DuPage Co., 1897, *Umbach;* Peoria, Peoria Co., 1900-4, *F. E. McDonald*.—WISCONSIN. Kaukanna, Outagamie Co., 1890-1, *Schuette*.—IOWA. Fayette, Fayette Co., 1894, *Fink;* Grinnell, Poweshiek Co., 1877, *M. E. Jones*.—MINNESOTA. Northern Minnesota, 1902, *MacDougal* (NY, type of *H. patens*); Minneapolis, Hennepin Co., 1890, *Sandberg*.—NORTH DAKOTA. Grand Forks, Grand Forks Co., *H. F. Bergman 1659*.—SOUTH DAKOTA. Sioux Falls, Minnehaha Co., 1894, *Thornber*.—NEBRASKA. Albright, Sarpy Co., *J. L. Morrison 979*.—MISSOURI. Courtney, Jackson Co., *Bush 4956, 7959;* Hannibal, Marion Co., *J. Davis 405*.—ARKANSAS. Batesville, Independence Co., *Demaree 17,111*.

This species has the widest range of any in the genus, but exhibits only a rather slight degree of variation, in pubescence, number of leaf divisions and in flower color. *Hydrophyllum patens*, segregated upon the basis of purple flowers, erect calyx lobes, spreading corolla lobes and ciliate petioles, seems to be an illusory unit of little taxonomic distinctness. The leaves of f. *simplicifolium*, which is apparently a sterile bud mutation, closely resemble those of *H. capitatum*.

1a. **Hydrophyllum virginianum** var. **atranthum** (Alexander) n. comb.
Hydrophyllum atranthum Alexander, Castanea **6**:31. 1941.

Like the species, but the leaflets frequently 7-9; flowers dark violet, the lobes said to exceed the tube; hairs of the scales and the filaments brown.

Type.—"Craggy Mtns., Buncombe Co., N. C.," June 23, 1939, *E. J. Alexander.*

Distribution.—West Virginia, western Virginia and North Carolina; at elevations of 1200-5500 feet.

Representative Specimens: WEST VIRGINIA. Fish Cr., Wetzel Co., *Core 2641;* Potts Mt., Monroe Co., *Hunnewell 11,946;* Elk Mt., Pocahontas Co., *C. A. & U. F. Weatherby 6420.*—VIRGINIA. Lower Cascades, Bath Co., 1932, *Wherry;* Bald Knob, 1923, *H. B. Meredith;* Briery Gap, Rockingham Co., *Eggleston 18,621;* Chatham Hill Gap, Smyth Co., *Small;* Hutton's Branch, Smyth Co., 1892, *Small.*—NORTH CAROLINA. Cedar Cliff Mt., Buncombe Co., *Biltmore Herb. 2547a;* Craggy Mts., Buncombe Co., 1939, *Alexander* (NY, type of *H. atranthum*); Junaluska Mt., Haywood Co., 1930, *Blomquist;* Cloudland, Roan Mt., Mitchell Co., *W. A. Cannon 41;* Grandfather Mt., Watauga Co., *Small & Heller 429.*

This entity is said to be distinguishable from typical *H. virginianum* by the possession of deeper-colored flowers, corolla lobes longer than the tube, hairs on the corolla scales brown, the stamens "shorter and more slender," their filaments brown, and more numerous leaf divisions. Its distribution is stated to be connected with the outlines of the ancient Teays River drainage, and it is believed to be a local species which has not spread from its place of origin. I am unable to distinguish any significant differences save the obvious one in color, and had supposed this to be only a color form comparable to those occurring in the closely related *H. tenuipes.* However, var. *atranthum* occurs at considerably higher altitudes than are usual for the species, and appears to be confined to one end of the species' range. Inasmuch as I am unfamiliar with the Appalachian area, it seems advisable to retain *H. atranthum* in varietal status under *H. virgianum,* where its relationships unquestionably lie. Because the distributional maps were made before the publication of this entity, and because Alexander cites only a very few of the collections I had examined, I cannot be sure that I have correctly separated the localities for the variety from those for the species.

2. HYDROPHYLLUM TENUIPES Heller

Hydrophyllum coelestinum Dougl. ex Benth. Trans. Linn. Soc. **17**:273. 1834, nomen in synon.
Hydrophyllum tenuipes Heller, Bull. Torrey Club **25**:582. 1898.
Hydrophyllum virginicum var. *pacificum* Eastwood ex Brand, Pflanzenr. 251: 35. 1913, nomen in synon.
Hydrophyllum tenuipes var. *viride* Jepson, Man. Fl. Pl. Calif. 811. 1925.
Hydrophyllum viridulum G. N. Jones, Univ. Wash. Publ. Biol. **7**:175. 1939.

Plants 2-6 dm. high, the stems retrorse-hispid throughout, perennial from a slender, scaly, elongated rhizome bearing fleshy-fibrous roots; leaves semi-orbicular in outline, excluding the petiole 8-20 cm. in diameter, pinnately divided, the principal divisions 5, or occasionally with 1-2 pairs of small

additional leaflets, ovate-lanceolate to ovate, acute, acuminate or rarely obtuse, 5-10 cm. long, the lower pair usually distinct and often deeply 2-parted, or all confluent, the terminal 3-cleft, all coarsely serrate to incised, the lobes ovate, acute to obtuse, mucronate, sparsely strigose on both surfaces, paler beneath; petiole 5-30 cm. long, retrorse-hispid; cauline leaves like the basal; inflorescence of several lax cymes, the peduncles 2-10 cm. long, usually branched, equalling to exceeding the subtending leaves, densely retrorse-hispid; pedicels 5-12 mm. long, spreading, strigulose; calyx divided nearly to the base, the lobes linear to linear-subulate, acute, 4-7 mm. long, 0.5-1 mm. broad, strigulose to glabrate on the back, strongly hispid-ciliate, sometimes enlarging slightly in fruit; corolla 5-7 mm. long, cream, greenish, purple or blue, the lobes oblong, obtuse or retuse, 3-4 mm. long; stamens exserted 5-8 mm. beyond the corolla, the anthers linear-oblong, 1-1.5 mm. long; style exserted 5-10 mm., the ovary hispid at the summit; fruit 3-5 mm. in diameter; seeds 1, yellowish- to reddish-brown, about 3.5 mm. in diameter.

Type.—"low, moist rich ground, along the Chehalis River . . . at Montesano, Chehalis Co., Wash.," May 31, 1898, *A. A. & E. G. Heller 3853.*

Distribution.—Vancouver Island and northern Washington, west of the Cascade Range, to Mendocino County, California; at elevations of 0-3000 feet.

Representative Specimens: BRITISH COLUMBIA. Goldstream, 1887, *J. Macoun 16,242.* —WASHINGTON. Olympic Mts., Clallam Co., *Elmer 2831;* Montesano, Grays Harbor Co., *A. A. & E. G. Heller 3853* (isotypes of *H. tenuipes*); Hoquiam, Grays Harbor Co., *F. H. Lamb 1140;* Quiniault Valley, Grays Harbor Co., *Conard 134;* Seattle, King Co., *Piper 260* (WS, type of *H. viridulum*); Tacoma, Pierce Co., 1901, *Flett;* Ilwaco, Pacific Co., *Piper 5000;* Lower Cascades, Skamania Co., *Suksdorf 885.*—OREGON. "Oregon & Washington Territory," 1838-42, *Wilkes Exped.;* Elk Rock, Clackamas Co., *Heller 10,053;* Big Cr., Clatsop Co., *Constance & Beetle 2662;* North Bend, Coos Co., *Constance & Beetle 2629;* Deer Cr., Lincoln Co., *Constance & Beetle 2640;* Sauvies Is., Multnomah Co., 1887, *T. Howell;* Latourelle Falls, Multnomah Co., *Thompson 4354;* Multnomah Falls, Multnomah Co., *Constance & Beetle 2664.*—CALIFORNIA. Little Mill Cr., Del Norte Co., *H. E. & S. G. Parks 24,040;* Redwood belt, Humboldt Co., *Chandler 1263;* Carlotta, Humboldt Co., *Constance & Beetle 2611;* Mendocino, Mendocino Co., *Brown 821* (basis of *H. virginicum* var. *pacificum*); Navarro River, Mendocino Co., *Constance 2511.*

This species was long confused with *H. virginianum,* from which it is separable chiefly by pubescence and by geographical distribution. Its chief variation is in flower color, and several local forms are recognizable. Piper (1906, p. 469) pointed out that, in his opinion, "two quite distinct forms of this species occur, but satisfactory characters to separate them are not evident. The coast form like Piper's 5000 has dark blue flowers on long peduncles, and thick leaves coarsely and doubly crenate-dentate, while the form away from the immediate coast has thinner leaves, simply dentate, and pale flowers on shorter peduncles." It was to the blue-flowered form that the name *H. coelestinum* was originally attached. In general, the greenish-white color phase is found from the Columbia River southward, the cream-colored occurs in the Columbia Gorge and western Washington and northwestern Oregon, and the blue or purple phase occurs near the mouth of the Columbia. There

is, however, much mingling of the various colors, and these do not seem to be attended by either concomitant variations or sharp geographical or ecological separation. Specimens collected away from the immediate coast in Oregon (e.g., *Constance & Beetle* 2662) sometimes combine thin leaves, which are variably dentate, with deep-colored flowers. To recognize these color forms as either species or varieties would appear to be attaching undue significance to a sporadic, albeit striking minor variation.

3. HYDROPHYLLUM FENDLERI (Gray) Heller

Hydrophyllum occidentale var. *Fendleri* Gray, Proc. Amer. Acad. **10**:314. 1875.
Hydrophyllum Fendleri Heller, Plant World **1**:23. 1897.
Hydrophyllum albifrons var. *Fendleri* Brand, Pflanzenr. 251: 34. 1913.

Plants 2.5-9 dm. high, the stems retrorse-hispid, perennial from a rather short, scaly rhizome bearing fleshy-fibrous roots; leaves oblong to oval in outline, excluding the petiole 6-30 cm. long, 5-20 cm. broad, pinnatifid, the principal divisions usually 9-13 (7-19), ovate to lanceolate, acuminate, 2-12 cm. long, the lower pairs usually distinct, the upper confluent, all coarsely serrate to incised, the lobes ovate-lanceolate, acuminate, mucronate, strigose on both surfaces, paler beneath and hispid on the veins; petiole 3-16 cm. long, retrorse-hispid; cauline leaves like the basal; inflorescence of one to several lax cymes, the peduncles 2-13 cm. long, freqeuntly bifurcate, usually exceeding the subtending leaves, strigose and hispid; pedicels 2-6 mm. long, spreading; calyx divided nearly to the base, the lobes linear-lanceolate, acute or acuminate, 4-6 mm. long, 1-2 mm. broad, sparsely strigose and often hispid on the back, strongly ciliate with flattened, hyaline hairs, nearly equalling the corolla, often enlarging slightly in fruit; corolla 6-8 mm. long, white or violet, or white and marked with violet, the lobes 3-4 mm. long, obtuse; stamens exserted 4-6 mm. beyond the corolla, the anthers linear-oblong, 1-2 mm. long; style exserted 5-7 mm., the ovary often short-pubescent, hispid at the summit; fruit about 4 mm. in diameter; seeds 1-3, light brown, 2.5-3 mm. in diameter.

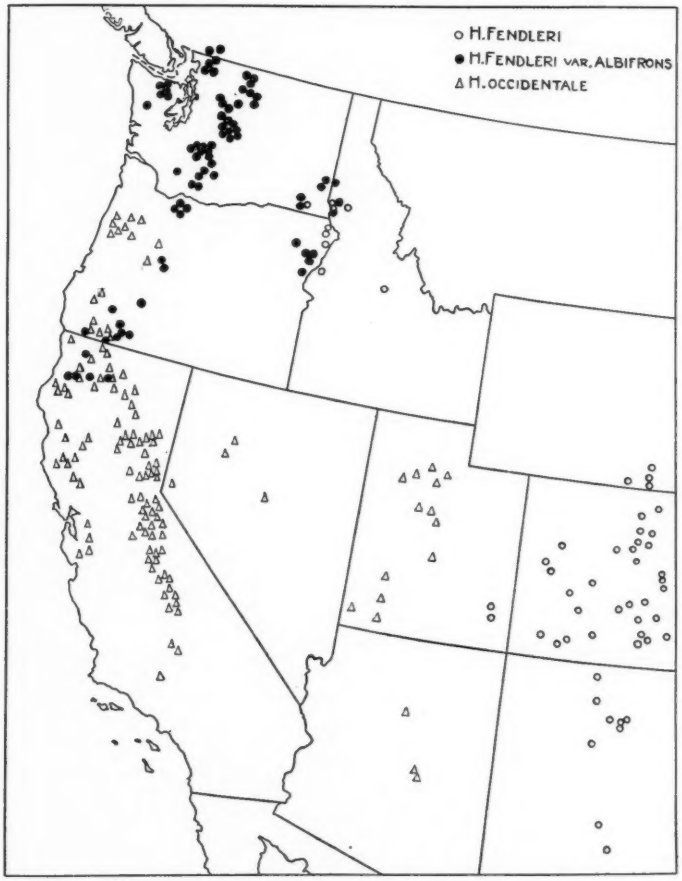
Type.—"Colorado, New Mexico" (Santa Fe Creek, New Mexico, *Fendler 841*).

Distribution.—Southern Wyoming and Colorado to southeastern Utah and New Mexico; northern Idaho, southeastern Washington and northeastern Oregon; at elevations of 1350-12,000 feet.

Representative Specimens: WYOMING. Chug Cr., Albany Co., *A. Nelson 7394;* Table Mt., Pole Cr., *A. Nelson 89.*—COLORADO. Horsetooth Gulch, Boulder Co., *Crandall 1597;* Boulder, Boulder Co., *Ramaley 15,978;* St. Charles River, Custer Co., *Rollins 1216;* Palmer Lake, El Paso Co., *A. Nelson 10,522;* Mt. Carbon, Gunnison Co., *Tidestrom 3479;* Fort Collins, Larimer Co., 1894-6, *C. F. Baker;* near Pagosa Peak, Mineral Co., *C. F. Baker 547;* Chicken Cr., Montezuma Co., *Baker, Earle & Tracy 156;* Cimarron, Montrose Co., *C. F. Baker 381.*—NEW MEXICO. Sierra Blanco Peak, Otero Co., *C. B. Wolf 2832;* Winsor Cr., San Miguel Co., *Standley 4043;* Santa Fe Cr., Santa Fe Co., *Fendler 841* (GH, type of *H. Fendleri*), *A. A. & E. G. Heller 3644.*—UTAH. Abajo Mts., San Juan Co., *Goodman & Hitchcock 1372, Maguire & Redd 2043.*—IDAHO. Granite Cr., Idaho Co., *J. Packard 259;* Mission Cr., Lewis Co., *St. John, Cary, Putnam & Warren 6328;* Lawyer Cr., Lewis Co., *Constance,*

Beetle & Ownbey 2740; Valley of Peter Cr., Nez Perce Co., *Sandberg, MacDougal & Heller 112* (in part).—WASHINGTON. Tucanon River Valley, Columbia Co., 1913, *H. T. Darlington.*—OREGON. Cottonwood Cr. Cañon, Wallowa Co., *Sheldon 8055;* Imnaha Canyon, Wallowa Co., *Peck 18,382.*

This species has been confused with *H. virginianum,* to which fact is owed the report of that eastern species from Colorado, and with *H. occidentale.* The discontinuous range of *H. Fendleri* is quite remarkable, and it seems likely that it will be discovered somewhere in the intervening area, as in northern Utah or western Wyoming. The presence of the species in Wash-



ington, Oregon and Idaho, which had not previously been detected, and the existence of plants transitional in their characters (e.g., *Sandberg, MacDougal & Heller 112, St. John & Smith 8308*), firmly connect the species with var. *albifrons*.

3a. HYDROPHYLLUM FENDLERI var. ALBIFRONS (Heller) Macbr.

Hydrophyllum albifrons Heller, Bull. Torrey Club **25**:267. 1898.
Hydrophyllum congestum Wiegand, Bull. Torrey Club **26**:136. 1899.
Hydrophyllum albifrons var. *eu-albifrons* subvar. *pendulum* Brand, Pflanzenr. 251: 34. 1913.
Hydrophyllum Fendleri var. *albifrons* Macbr. Contr. Gray Herb. **49**: 23. 1917.

Stems, peduncles, petioles and pedicels hirsutulous; leaves strigulose above, paler beneath with short, sub-appressed, soft hairs; sepals linear-oblong to -lanceolate, acute or acuminate, 3-5 mm. long, 0.5-1.5 mm. broad, strigulose with soft hairs on the back, weakly ciliate with flattened hairs, much shorter than the corolla; corolla 7-10 mm. long.

Type.—"Woods at the head of Lake Waha, Nez Perce Co., Idaho," alt. 2000 feet, *A. A. & E. G. Heller 3269*.

Distribution.—Cascade Range from southern British Columbia to northern California; Olympic Mountains; southeastern Washington, northwestern Idaho and northeastern Oregon; at elevations of 1200-7000 feet.

Representative Specimens: BRITISH COLUMBIA. First summit west of Skagit River, *J. M. Macoun 76,745;* Chilliwack Valley, *J. M. Macoun 54,325.*—WASHINGTON. Stuart Ridge, Chelan Co., *Thompson 11,719;* Olympic Mts., Clallam Co., *Elmer 2828;* Mt. Angeles, Clallam Co., *Thompson 7505;* Wildcat Spr., Columbia Co., *St. John & Smith 8308;* Table Mt., Kittitas Co., *Thompson 9261;* Mt. Paddo, Klickitat Co., *Suksdorf 591;* Nason Cr., Okanogan Co., *Sandberg & Leiberg 658;* Mt. Tacoma, Pierce Co., *Flett* (CU, type of *H. congestum*); Goat Mts., Pierce Co., *O. D. Allen 232;* Mt. Hermann, Whatcom Co., *Thompson 5411;* Pullman, Whitman Co., *Piper 1697, Elmer 152;* Simcoe Mts., Yakima Co., 1881, *T. Howell.*—IDAHO. Paradise Hills, Latah Co., *Henderson 2749;* Lake Waha, Nez Perce Co., *A. A. & E. G. Heller 3269* (isotypes of *H. albifrons*); Valley of Peter Cr., Nez Perce Co., *Sandberg, MacDougal & Heller 112* (in part).—OREGON. Paddy's Cr., Baker Co., *Cusick 2240;* Clackamas Lake, Clackamas Co., *Peck 15,844;* Elk River, Hood River Co., *L. Benson 2526;* Dead Indian Cr., Jackson Co., *Applegate 2428.*—CALIFORNIA. Trinity Summit, Humboldt Co., *Tracy 10,602;* Marble Mt., Siskiyou Co., *Butler 1720;* Shasta Springs, Siskiyou Co., *Eastwood 11,844;* Big Flat, Trinity Co., *J. T. Howell 13,575.*

The variety has also an interrupted range, but attempts to divide these geographically isolated populations taxonomically have failed signally to distinguish natural entities. The occurrence of the species and variety together in the Blue Mountains and in northern Idaho, near the type locality of *H. albifrons*, and the inclusion of both in one of the co-type collections of the latter (e. g., *Sandberg, MacDougal & Heller 112*), breaks down completely their supposed geographical distinctness. The distinctions between the species and variety are primarily those of pubescence and relative length of calyx and corolla. Intermediates occur in the region of overlapping, so varietal separation would appear to most accurately depict their relationship to each other.

4. HYDROPHYLLUM OCCIDENTALE (Wats.) Gray

Hydrophyllum speciosum Nutt. ex. Hook. Kew Journ. Bot. **3**: 293. 1851, nomen in synon.
Hydrophyllum macrophyllum var. *occidentale* Wats. Bot. King Exped. 248. 1871.
Hydrophyllum occidentale Gray, Proc. Amer. Acad. **10**:314. 1875.
Hydrophyllum occidentale var. *Watsoni* Gray, op. cit. p. 314.
Hydrophyllum Watsoni Rydb. Bull. Torrey Club **40**:478. 1913.

Plants 1-6 dm. high, the stems densely short-pubescent to somewhat retrorse-hispid, perennial from a shortened rootstock bearing fleshy-fibrous roots; leaves oblong in outline, excluding the petiole 5-30 cm. long, 3-15 cm. broad, pinnatifid, the principal divisions 7-15, broadly oblong to ovate, obtuse, 1.5-7 cm. long, the lower pairs distinct, the upper confluent, all incised or lobed to rarely entire, the lobes ovate, abruptly acute or obtuse, mucronate, strigulose above, paler beneath with dense, fine, subappressed hairs; petiole 2.5-15 cm. long, short-pubescent and occasionally hispid; cauline leaves like the basal; inflorescence of one to several globose cymes, the peduncles 5-30 cm. long, often branched and usually exceeding the subtending leaves, short-pubescent; pedicels 2-5 mm. long, densely short-pubescent; calyx divided nearly to the base, the lobes narrowly lanceolate, abruptly acute, 3-4 mm. long, 1-2 mm. broad, strigulose on the back, strongly hispid-ciliate, somewhat accrescent in fruit; corolla 7-10 mm. long, violet to white, the lobes 4-6 mm. long, oblong, obtuse; stamens exserted 4-6 mm. beyond the corolla, the anthers linear-oblong, 1.5-2 mm. long; style exserted 5-8 mm., the ovary densely pubescent and hispid at the summit; fruit about 4 mm. in diameter; seeds 1-2, brown, about 3 mm. in diameter.

Type.—"California."

Distribution.—Western Oregon south in the Coast Ranges to central California and in the Cascades and Sierra Nevada to the Tehachapi Mountains; mountains of Nevada, Utah and Arizona; at elevations of 250-9500 feet.

Representative Specimens:—OREGON. "Wahlamet River," *Nuttall* (PA, basis of *H. speciosum*); Philomath, Benton Co., *Gorman 5701;* Myrtle Cr., Douglas Co., *Mrs. N. P. Gale 50;* Ragsdale Butte Lookout, Jackson Co., *Hitchcock & Martin 5034;* Oregon Caves, Josephine Co., *Thompson 12,951.*—CALIFORNIA. Mocho Cr., Alameda Co., *Elmer 4330;* Stirling, Butte Co., *Heller 10,830, 13,154;* above Jonesville, Butte Co., *Heller 12,030;* Mt. Diablo, Contra Costa Co., *Brewer 1176;* Bennett Spr., Glenn Co., *Heller 12,010;* Buck Mt., Humboldt Co., *Constance, Beetle & Tracy 2618;* Tehachapi Mts., Kern Co., *Hasse & Davidson 1738;* Mt. Sanhedrin, Lake Co., 1902, *Heller;* Diamond Mt., Lassen Co., 1897, *M. E. Jones;* Cahto, Mendocino Co., *Kellogg & Harford 782;* Knoxville, Napa Co., *C. F. Baker 3083;* Summit, Placer Co., *Heller 9838;* Little Gray Eagle Cr., Plumas Co., *Bacigalupi 1735;* Madrone Sprs., Santa Clara Co., *Dudley 4077;* Mt. Hamilton, Santa Clara Co., *Heller 8613;* Goose Valley, Shasta Co., *Eastwood 818;* Yuba Pass, Sierra Co., *Constance 2305;* Oro Fino, Siskiyou Co., *Butler 1241;* Low Gap, Trinity Co., *Constance, Beetle & Tracy 2616;* Mineral King, Tulare Co., *Coville & Funston 1497;* Duffield's Ranch, Tuolumne Co., *Bigelow 37.*—NEVADA. Lynch Canyon, Lander Co., *A. R. Torgerson 62;* West Humboldt Mts., Pershing Co., *Watson 865* (GH, type of *H. Watsoni*).—UTAH. Mt. Nebo, Juab Co., *R. K. Gierisch;* Salt Lake City, Salt Lake Co., 1890, *M. E. Jones 1704;* Wahsatch Mts., Summit Co., *Watson 866;* 50 miles northwest of St. George, *E.*

Palmer 331.—ARIZONA. Oak Cr. Canyon, Coconino Co., *A. & R. A. Nelson 2112;* Barnhart Pass, Gila Co., *Mrs. R. E. Collom 108.*

This species has been much confused, first with *H. capitatum* and *H. macrophyllum*, and subsequently with *H. Fendleri* and var. *albifrons*. Some collections from the mountains of southern Oregon are difficult to separate from *H. Fendleri* var. *albifrons*, but the two are apparently amply distinct. The species exhibits considerable variation in pubescence, the Great Basin and much of the Californian material having a softer pubescence than that of the Oregon and some of the northern Californian material. The former phase is the basis for *H. Watsoni*, and the latter for *H. speciosum*, but this distinction does not appear to be sufficiently clear-cut to make even varietal segregation of value.

5. HYDROPHYLLUM MACROPHYLLUM Nutt.

Hydrophyllum macrophyllum Nutt. Journ. Acad. Philad. **7**:111. 1834.
Hydrophyllum hispidum Riddell, Syn. Fl. West. States Amer. 84. 1835.

Plants 2-9 dm. high, the stems short-pubescent and densely retrorse-hispid, perennial from a scaly, elongated rhizome bearing fleshy-fibrous roots; leaves oblong to oblong-oval in outline, excluding the petiole 7-30 cm. long, 5-19 cm. broad, pinnatifid, the principal divisions 7-13, ovate, obtuse to acute, 2-8 cm. long, the lower pairs distinct, or these and the upper confluent, coarsely dentate or incised, the teeth ovate, acute, mucronate, strigose on both surfaces, paler and hispid on the veins beneath; petiole 3-22 cm. long, densely retrorse-hispid; cauline leaves like the basal, or broader and with fewer lobes; inflorescence of one to several subglobose cymes, the peduncles 3-22 cm. long, often bifurcate and usually exceding the subtending leaves, densely short-pubescent and hispid; pedicels 2-8 mm. long, densely short-pubescent and hispid; calyx divided about two-thirds, the lobes triangular- to subulate-lanceolate, 5-7 mm. long, 0.5-2.5 mm. broad, densely short-pubescent and coarsely hispid on both surfaces, strongly hispid-ciliate, somewhat accrescent in fruit; corolla 7-12 mm. long, dull white, the lobes 4-6 mm. long, oblong, obtuse or retuse; stamens exserted 4-6 mm. beyond the corolla, the anthers linear-oblong, 1.5-2 mm. long; style exserted 5-10 mm., the ovary densely short-pubescent, hispid at the summit; fruit 3-4 mm. in diameter; seeds not seen.

Type.—"In the forests of Kentucky," *Short.*

Distribution.—Ohio, Indiana and Illinois to western Virginia and northern Alabama; at elevations up to 4500 feet.

Representative Specimens: OHIO. Loveland, Clermont Co., 1883, *J. F. James;* Cincinnati, Hamilton Co., 1880-90, *C. G. Lloyd.*—INDIANA. Hanover, Jefferson Co., 1872-4, *Coulter;* Van Buren, Grant Co., *Deam 2055.*—ILLINOIS. Olney, Richland Co., *A. H. Harwell 545.*—KENTUCKY. "In the forests of Kentucky," *Short* (PA, isotype of *H. macrophyllum*); "Kentucky," 1854-7, *Short;* Kuttawa, Lyon Co., *Eggleston 4626.*—TENNESSEE. Nashville, Davidson Co., 1886, *Gattinger;* Knoxville, Knox Co., 1898-1903, *A. Ruth.*—?WEST VIRGINIA. Harpers Ferry, Jefferson Co., *Pursh 26.*—VIRGINIA. Hungry Mother Cr., Smyth Co., 1892, *Small;* Washington Co., 1872, *Curtiss;* Wytheville, Wythe Co., 1874-8, *H. Shriver.*—NORTH CAROLINA. Biltmore, Buncombe Co., *Biltmore Herb. 528, 528b;* Bull Cr., Buncombe Co., *Biltmore Herb. 528a.*—ALABAMA. Alabama, *Buckley;* Tennessee River, Colbert Co., *Harper 3216.*

Despite its rather close resemblance to certain Oregon material of *H. occidentale* in foliage, this species is well set off from all others by its shallowly lobed calyx and usually also by its very hispid pubescence.

6. HYDROPHYLLUM CAPITATUM Dougl.

Hydrophyllum capitatum Dougl. ex Benth. Trans. Linn. Soc. **17**:273. 1836.
Hydrophyllum densiflorum Nutt. ex Hook. Kew Journ. Bot. **3**:292. 1851, nomen in synon.
Hydrophyllum pumilum Geyer ex Hook. op. cit. p. 292, nomen in synon.
Hydrophyllum capitatum var. *pumilum* Hook. op. cit. p. 292.
Hydrophyllum capitatum var. *pumilum* subvar. *densum* Brand, Pflanzenr. 251: 33. *fig.* 5. 1913.
Hydrophyllum capitatum var. *alpinum* subvar. *laxum* Brand, op. cit. p. 33.

Plants 1-4.5 dm. high, the stems very short, spreading-hirsutulous, perennial from a very short rhizome bearing a fascicle of fleshy-tuberous, finger-like roots; leaves ovate to oval in outline, excluding the petiole 5-12 cm. long, 3-12 cm. broad, pinnately parted or divided, the principal divisions 5-7, obovate to oblong or lanceolate, obtuse or acute, 2-5 cm. long, the lower pair distinct, the upper or all confluent, the larger cleft or divided into oblong, entire, mucronate lobes, appressed-hirsutulous; cauline leaves few, like the basal; inflorescence of one to several globose cymes, the peduncles 1-5 cm. long, occasionally branched, conspicuously shorter than the subtending leaves, spreading hirsutulous, usually recurved in fruit; pedicels 2-5 mm. long, hirsutulous; calyx divided nearly to the base, the lobes linear-oblong, obtuse or abruptly acute, 3-4 mm. long, 0.5-1.5 mm. broad, densely appressed-hirsutulous on the back, strongly ciliate with flattened hairs, somewhat accrescent in fruit; corolla 5-9 mm. long, purplish-blue to white, the lobes 3-5 mm. long, oblong-obovate, obtuse or retuse; stamens exserted about 5 mm. beyond the corolla, the anthers short-oblong, 0.7-1 mm. long; style exserted 5-10 mm., the ovary hirsutulous, hispid at the summit; fruit about 4 mm. long; seeds usually 2, light brown, 2-3 mm. in diameter.

Type.—"in fissures of moist rocks in the interior of Columbia in Northwest America," 1826, *Douglas*.

Distribution.—Southwestern Alberta and western Montana to southeastern British Columbia, south to western Colorado, northern Utah and northeastern Oregon; at elevations of 1250-10,000 feet.

Representative Specimens:—ALBERTA. Castle River Forest Station, *Brinkman 3094*. —MONTANA. Bozeman, Gallatin Co., 1901, *W. W. Jones;* Bridger Mts., Gallatin Co., *Rydberg & Bessey 4861;* Midvale, Glacier Co., *Umbach 51*.—IDAHO. Boise, Boise Co., *J. A. Clark 1;* Big Willow, Canyon Co., *Macbride 111;* Sheep Cr., Idaho Co., *Constance & Rollins 1027;* Kootenai Co., 1890-2, *Leiberg;* Mt. Baldy, Lemhi Co., *Payson & Payson 1857;* Lewiston, Nez Perce Co., *A. A. & E. G. Heller 3065;* Clearwater River, Nez Perce Co., *Sandberg, MacDougal & Heller 29;* Silver City, Owyhee Co., *Macbride 933*.—BRITISH COLUMBIA. Sophie Mt., *J. M. Macoun 66,615;* Trail, *J. M. Macoun 66,617*.—WASHINGTON. "Washington Terr.," 1838-42, *Wilkes Exped. 831;* Bear Cr. trail, Garfield Co., *D. L. Peters 381;* Ellensburg, Kittitas Co., *Thompson 5942, 8219;* Liberty, Kittitas Co., *Thompson 11,449;* Hangman Cr., Spokane Co., *Sandberg & Leiberg 45;* Harts Pass, Whatcom Co., *Muenscher 10,058;* Pullman,

Whitman Co., *Piper 1696, 1893;* Simcoe Mts., Yakima Co., 1879, *J. Howell.*—OREGON. Middle Fork Burnt River, Baker Co., *Constance & Beetle 2721;* Prairie City, Blue Mts., Grant Co., *Henderson 5090;* Union Co., *Cusick 1600;* Mouth of Battle Cr., Wallowa Co., *Peck 18,175;* Horse Cr. Cañon, Wallowa Co., *Sheldon 8039.*—WYOMING. Afton, Lincoln Co., *Payson & Armstrong 3283;* Jenny Lake, Teton Co., *Williams & Pierson 867;* Battle, Carbon Co., *Tweedy 4562.*—YELLOWSTONE NATIONAL PARK. Glen Cr., *A. & E. Nelson 5557.* Mammoth Hot Sprs., 1893, *Burglehous.*—COLORADO. Grand Mesa, Delta Co., *C. F. Baker 231;* Mt. Carbon, Gunnison Co., *Eggleston 5665;* Tabeguache Basin, Montrose Co., *Payson 390;* Rabbit Ear Range, Routt Co., *Goodding 1579.*—UTAH. Big Cottonwood Cañon, *Rydberg & Carlton 6519;* Willard, Box Elder Co., *B. & R. Maguire 3683;* Logan Canyon, Cache Co., *C. P. Smith 1562, 2329, Muenscher & Maguire 2406;* Mt. Nebo, Juab Co., *Goodding 1099;* City Cr. Cañon, Salt Lake Co., *M. E. Jones 1666,* 1900, *Stokes;* Parley's Peak, Summit Co., *Watson 867;* Provo, Utah Co., *M. E. Jones 5578;* Wolf Cr. Pass, Wasatch Co., *E. H. Graham 8140.*

The varieties and subvarieties admitted by Brand were based chiefly upon such variables as degree of condensation of the inflorescence and the length of the leaves. Both of these conditions are, as might be anticipated, extremely plastic, susceptible of modification, and of little taxonomic worth. Bentham apparently included in *H. capitatum* not only those plants commonly referred here, but also the very different *H. tenuipes* and *H. occidentale.*

6a. **Hydrophyllum capitatum** var. **Thompsoni** (Peck) n. comb.

Hydrophyllum Thompsoni Peck, Torreya **28**: 55. 1928.

Inflorescence compact even in fruit, borne well above the ground and conspicuously exceeding the subtending leaves, the peduncles 5-20 cm. long, not recurving in fruit; filaments sparsely villous to nearly glabrate.

Type.—"Near Multnomah Falls, Multnomah County, Oregon," *Peck 7782.*

Distribution.—Columbia River Gorge and vicinity, south-central Washington and adjacent Oregon; at elevations of 100-3000 feet.

Representative Specimens: WASHINGTON. Bingen, Klickitat Co., 1881, *Suksdorf 6435, Thompson 8157;* Satus Pass, Yakima Co., *Hitchcock & Marsh 3293.*—OREGON. "Oregon," *Suckley;* Hood River, Hood River Co., *Thompson 4052;* Bonneville, Multnomah Co., *Thompson 798;* Mosier, Wasco Co., 1893, *T. Howell, Constance & Beetle 2670;* The Dalles, Wasco Co., *Lunell 11,584, Thompson 4091, 11,355.*

Of the characters originally used to distinguish this entity from *H. capitatum,* only that of peduncle length seems to be at all constant. Although this is admittedly a character of degree, and sporadic variation in length of peduncle occurs throughout the species population, it nevertheless serves to set apart a small but striking, geographically localized variant. The variety merges completely with the species, especially toward the north in the Yakima-Wenatchee region (e.g., *Thompson 5942, 8219, 10,484, 11,449*).

6b. HYDROPHYLLUM CAPITATUM var. ALPINUM Wats.

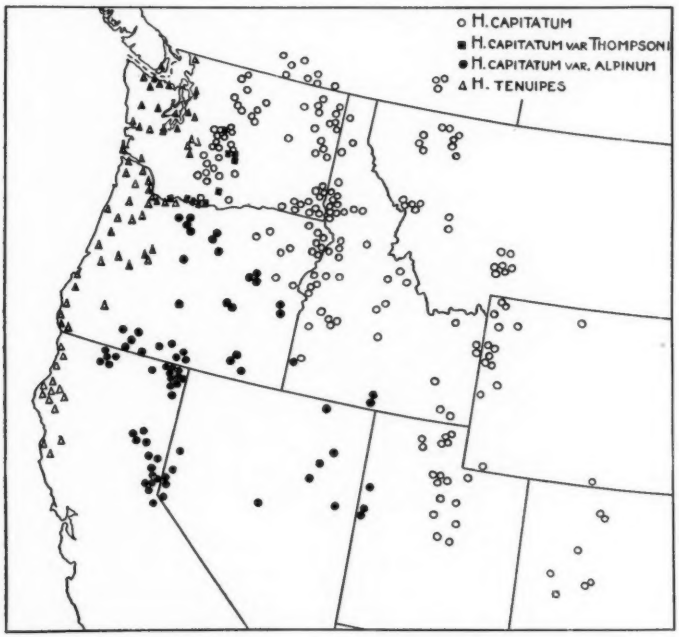
Hydrophyllum capitatum var. *alpinum* Wats. Bot. King Exped. 249. 1871.
Hydrophyllum alpestre Nelson & Kennedy, Muhlenbergia **3**:142. 1908.
Hydrophyllum alpinum Greene ex Brand, Pflanzenr. 251:33. 1913, nomen in synon.

Plants nearly acaulescent, with somewhat more abundant and more spreading pubescence; inflorescence borne near the surface of the ground and exceeded by the subtending leaves, lax at least in fruit, the peduncles 1-5 cm. long; fruiting pedicels 5-20 mm. long, spreading or reflexed.

Type.—"East Humboldt Mts., Nevada; rocky ridge at 9,000 feet altitude," July, *Watson 868*.

Distribution.—Northern Great Basin: central Oregon and southwestern Idaho to western Utah, northern Nevada and northeastern California; at elevations of 2500-10,000 feet.

Representative Specimens: OREGON. Condon, Gilliam Co., *Constance & Beetle 2700;* Wildhorse Cr., Harney Co., *Peck 14,142;* Mt. Hood, Hood River Co., *Peck 17,294;* Swan Lake Valley, Klamath Co., *Applegate 360;* Klamath Falls, Klamath Co., *Henderson 9352;* Bullard Cañon, Lake Co., *Eggleston 6930;* Harper Ranch, Malheur Co., *Leiberg 2127;* Butte Cr., Wheeler Co., *Constance & Beetle 2707.*—IDAHO. Third Fork Rock Cr., Cassia Co., *R. K. Gierisch 658;* Silver City, Owyhee Co., *Christ & Ward 8076.*—UTAH. Granite Canyon, Juab Co., *Maguire & Becraft 2748;* Sheba Mine, Tooele Co., *Cottam 3180.*—NEVADA. Glenbrook, Douglas Co., *C. F. Baker 998;* East Humboldt Mts., Elko Co., *Watson 868* (GH, type of var. *alpinum*); Jarbidge Peak, Elko Co., *Nelson & Macbride 1977;* Hunter Cr. Cañon, Washoe Co., *P. B. Kennedy 1655;* Marmol Station, Washoe Co., *P. B. Kennedy 1858;* Peavine Mt., Washoe Co., *Heller 9731.*—CALIFORNIA. "Upper Sacramento," *Fremont 371;*



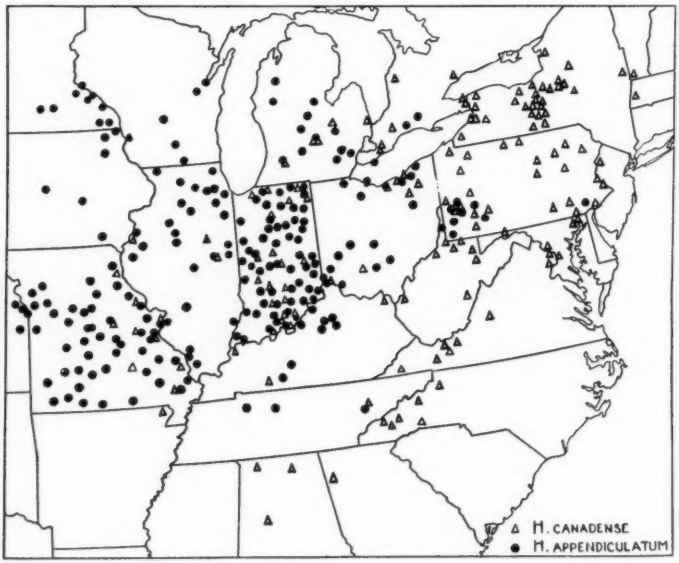
"High Sierras," *Lemmon;* Fredonyer Pass, *Constance 2325;* Fort Bidwell, Modoc Co., *Mrs. M. H. Manning 87;* Goose Lake Valley, Modoc Co., *Austin;* Truckee, Nevada Co., *Sonne 236, Bolander & Kellogg;* Deer Park, Placer Co., *Eastwood 388;* Chester, Plumas Co., *Heller 15,097;* Sierra Valley, Sierra Co., *Lemmon 210;* Bull Meadows, Siskiyou Co., *Butler 1324;* Yreka, Siskiyou Co., *Greene 736.*

The authors of *H. alpestre* remarked that, "there is positively nothing to indicate that it runs into *H. capitatum*," and Heller later affirmed that this entity had "nothing to do with that species" (but continued to distribute specimens of var. *alpinum* as "*H. capitatum*"). However, the variety and the species do become completely indistinguishable in at least two areas, the southern Blue Mountains of eastern Oregon (e. g., *Henderson 5090*) and in northern Utah. Throughout much of the sagebrush region, however, var. *alpinum* is a characteristic and rather uniform entity, and hence deserving of varietal status.

7. HYDROPHYLLUM CANADENSE L.

Hydrophyllum canadense L. Sp. Pl. ed. 2. 208. 1762.
Hydrophyllum acerifolium Salisb. Prodr. 120. 1796.
Hydrophyllum lobatum Stokes, Bot. Mat. Med. **1**:302. 1812.

Plants 1.5-9 dm. high, the stems glabrate to sparsely retrorse-hispid, perennial from an elongated, scaly rhizome bearing fleshy-fibrous roots; cotyledons oval to oblong-oval, 13-22 mm. long, 8-13 mm. broad, on petioles 20-40 mm. long; basal leaves oblong in outline, excluding the petiole 14-27 cm. long, 6-12 cm. broad, pinnatifid, the principal divisions 7-11, ovate or



rhombic, acute or obtuse, 1.5-6.5 cm. long, the lowest pair or pairs small and remote, the terminal confluent, all coarsely dentate to incised, the lobes acute or acuminate, mucronate, sparingly strigulose on both surfaces, or paler and glabrate beneath, or the basal leaves like the cauline; petiole 5-30 cm. long, sparsely hispid; cauline leaves orbicular to sub reniform, 5-30 cm. in diameter, cordate at base, shallowly palmately 5-9-lobed, or the lower divided, the lobes acuminate, coarsely dentate or incised; inflorescence of one to several lax cymes, the peduncles 1-15 cm. long, often branched, usually shorter than the subtending leaves, sparsely strigulose and hispid or glabrate; pedicels 3-10 mm. long, spreading or reflexed, strigulose; calyx divided nearly to the base, the lobes linear- to subulate-lanceolate, acute, 3-7 mm. long, 1-1.5 mm. broad, strigulose or glabrate on the back, weakly hispid-ciliate, scarcely enlarged in fruit, the sinuses very rarely and then minutely auriculate; corolla 7-11 mm. long, white to purplish, the lobes oblong-oval, 3-5 mm. long, obtuse or retuse; stamens exserted 3 6 mm. beyond the corolla, the anthers linear-oblong, 1.5-2 mm. long; style exserted 4-5 mm., the ovary hispid at the summit, sparsely strigose or otherwise glabrous; fruit 3-4 mm. in diameter; seeds 1-2, light to dark brown, 3-4 mm. in diameter.

Type.—"Canada."

Distribution.—Massachusetts and Vermont to Ontario and Illinois, south to North Carolina, northern Alabama and eastern Missouri; at elevations up to 4500 feet.

Representative Specimens: VERMONT. Hoosac River, Bennington Co., 1904, *J. R. Churchill.*—NEW YORK. Buffalo, Erie Co., *Clinton;* Lockport, Niagara Co., 1892, *E. C. Townsend;* Taughannock Ravine, Tompkins Co., 1895, *Wiegand.*—ONTARIO. Wingham, *J. A. Morton 2999.*—MICHIGAN. Port Huron, St. Clair Co., *C. K. Dodge.*—PENNSYLVANIA. Laschells Hollow, Allegheny Co., *J. A. Shafer 201;* Peach Bottom, Lancaster Co., 1863-4, *Porter;* Westmoreland Co., 1876-7, *Pierron.*—OHIO. Berea, Cuyahoga Co., 1897, *Ashcraft;* Cincinnati, Hamilton Co., *C. G. Lloyd.*—INDIANA. St. Joe, DeKalb Co., *Deam 20,230;* South Bend, St. Joseph Co., 1911, *Nieuwland.*—ILLINOIS. Oquawka, Henderson Co., *H. N. Patterson;* Cropsey, McLean Co., *Moldenke 7619.*—NEW JERSEY. Delaware, Warren Co., *Mackenzie 7091.*—MARYLAND. Plummers Is., Montgomery Co., *S. F. Blake 9463,* 1897, *Pollard.*—WEST VIRGINIA. Milton, Cabell Co., *L. G. Williams 701;* Little Falls, Monongalia Co., *Millspaugh 208.*—VIRGINIA. Vicinity of Washington, Alexandria Co., *Hunnewell 9614;* Hills east of Marion, Smyth Co., *N. L. & E. G. Britton & Vail.*—NORTH CAROLINA. Cullowhee Mt., *Biltmore Herb. 4013a;* Hewitt's Station, Swain Co., *Biltmore Herb. 4013;* Blowing Rock, Watauga Co., *Small & Heller 266;* Mt. Mitchell, Yancey Co., *Biltmore Herb. 4013b.*—GEORGIA. Banks of the Coosa, *Chapman.*—ALABAMA. Sheffield, Colbert Co., *Harper 3215;* Monte Sano, Madison Co., 1932, *Harper.*—TENNESSEE. Knoxville, Knox Co., 1923, *Bechtel.*—ARKANSAS. Clay Co., 1893, *Eggert.*—KENTUCKY. "Big Woods," Greenup Co., *Smith, Hodgdon, Gilbert & McCoy 3584.*—MISSOURI. Hematite, Jefferson Co., 1893, *Eggert;* Mill Cr., Lincoln Co., *Steyermark 25,993;* Cliff Cave, St. Louis Co., *Eggert;* Messler, Stoddard Co., *E. J. Palmer 34,856.*

This species has, on the southern flange of its distribution, some plants which are considerably more pubescent than the average, but exhibits little other variation. The occasional occurrence of auricles on the calyx in this species (e. g., Madison Co., Ala., 1932, *Harper*) serves to connect *H. appendiculatum* with the other species of the genus, and thus helps to break down the generic distinctness of *Decemium.*

8. HYDROPHYLLUM APPENDICULATUM Michx.

Hydrophyllum appendiculatum Michx. Fl. Bor. Amer. **1**:134. 1803.
Hydrophyllum trilobum Raf. Fl. Ludov. 33. 1817.
Nemophila paniculata Spreng. Syst. **1**:569. 1825.
Decemium hirtum Raf. Med. Fl. **2**:215. 1830.
Decemium appendiculatum Brand, Pflanzenr. 251: 37. 1913.
Hydrophyllum hirtum Willd. ex Brand, op. cit. p. 37, nomen in synon.

Plants 2-6 dm. high, the stems pubescent and hirsute, somewhat viscid above, with clustered leaf-bases at its base, biennial from a slender tap root bearing fibrous roots; basal leaves oblong in outline, 5-16 cm. long, 4-11 cm. broad, pinnatifid, the principal divisions 5-9, ovate-lanceolate to rhombic-ovate, acute, 1-6 cm. long, the lower pairs small and remote, the terminal confluent, all coarsely dentate, the teeth ovate, acute, mucronate, finely strigose and hispid on both surfaces, paler beneath, or the basal leaves like the cauline; petiole 5-16 cm. long, short-pubescent and hispid; cauline leaves orbicular, 5-15 cm. in diameter, usually cordate at base, palmately, or the lower subpinnately, shallowly 5-7-lobed, the lobes angulate, acuminate or acute, dentate, the teeth acute, mucronate, or the uppermost leaves narrow and bract-like; inflorescence of several lax cymes, the peduncles 3-9 cm. long, branched, exceeding the subtending leaves, densely short-pubescent and hispid; pedicels 5-20 mm. long, spreading or reflexed, short-pubescent and hispid; calyx divided nearly to the base, the lobes triangular- to subulate-lanceolate, acuminate, 4-8 mm. long, 1-2 mm. broad, strigose and hispid on the back, strongly hispid-ciliate, almost twice as large in fruit, the sinuses provided with lanceolate, reflexed auricles 1-1.5 mm. long and nearly twice as large in fruit; corolla sub-pelviform, 9-14 mm. long, lavender to violet, the lobes oval to obovate, 5-7 mm. long, obtuse or retuse; stamens exserted 1-3 mm. beyond the corolla, the anthers linear, 2-3 mm. long; style exserted 1-3 mm., the ovary short-pubescent, hispid at the summit; fruit about 3 mm. in diameter; seeds 1, reddish-brown, about 2 mm. in diameter.

Type.—"In sylvis montanis Tennasee," *Michaux.*

Distribution.—Southern Ontario to Michigan and southeastern Minnesota, south to southwestern Pennsylvania, Tennessee, Missouri and eastern Kansas; at low elevations.

Representative Specimens: ONTARIO. Tilsonburg, *J. Macoun 54,331.*—OHIO. Cincinnati, Hamilton Co., 1881-91, *C. G. Lloyd;* Oberlin, *Lorain Co.*, 1890-8, *Kofoid.*—PENNSYLVANIA. Pittsburgh, Allegheny Co., 1869-71, *Knipe;* Sylvania, Bradford Co., *Darlington.*—WEST VIRGINIA. Wheeling, Ohio Co., 1877-98, *Mertz.*—INDIANA. Woollen's Gardens, Marion Co., *S. McCoy 3793;* Evansville, Vanderburgh Co., *Benke 2490.*—KENTUCKY. Mammoth Cave, Edmonson Co., 1899, *E. Palmer;* Frankfort, Franklin Co., *Pennell 10,722.*—TENNESSEE. Nashville, Davidson Co., *Gattinger;* Erin, Houston Co., *E. B. Harger 7841.*—MICHIGAN. Alma, Gratiot Co., 1891-6, *C. A. Davis;* Ann Arbor, Washtenaw Co., *F. J. Hermann 6530.*—WISCONSIN. Pittsfield, Brown Co., 1887, *Schuette;* Appleton, Outagamie Co., 1896, *H. P. Chandler.*—MINNESOTA. Lake Madison, Blue Earth Co., 1891, *Sheldon;* Spring Grove, Houston Co., *Rosendahl 589.*—IOWA. Fayette, Fayette Co., *Fink;* Grinnell, Poweshiek Co., 1877, *M. E. Jones.*—ILLINOIS. Oquawka, Henderson Co., 1872, *H. N. Patterson;* Cawford bridge, Macon Co., *Clokey 2385;* Bluffs, St. Clair Co., 1875-7, *Eggert.*—KANSAS. Miami Co., *Oyster 5041;* Woods, Wyandotte Co., *A. S. Hitchcock 1063.*—MISSOURI. Hematite, Jefferson Co., 1893, *Eggert;* Jerome, Phelps Co., *J. H. Kellogg 481;* Galena, Stone Co., *E. J. Palmer 5705.*

Despite the auriculate and strongly accrescent calyx, the somewhat shallower corolla, the less exserted stamens with narrower anthers, and the biennial habit, it is believed that retention with the genus *Hydrophyllum* is the most satisfactory disposition of this species. The segregates proposed by Rafinesque seem to be of very trivial value, and have not been taken up. It has not been possible to substantiate the occurrence of this species in New York, where it has been reported, so such records have been excluded from the distribution and the accompanying map.

SPECIES EXCLUDED

1. *Hydrophyllum Aldea* Roem. & Schult. Syst. **4**:114. 1819.=Phacelia pinnata (Vahl) Macbr.

2. *Hydrophyllum cocinchinense* Lour. ex Steud. Nom. ed. 2. **1**:783. 1840, nomen nudum.= ?

3. *Hydrophyllum erectum* Sesse & Mocino, La Naturaleza. s. 2. **2**: App. 34. 1887.= ?

4. *Hydrophyllum lineare* Pursh, Fl. Amer. Sept. **1**:134. 1814.=Phacelia linearis (Pursh) Holz.

5. *Hydrophyllum magellanicum* Lam. Journ. Hist. Nat. Paris **1**:373. *pl. 19*. 1792.=Phacelia magellanica (Lam.) Coville.

6. *Hydrophyllum magellanicum acutilobum* Macloskie, Rep. Princeton Univ. Patagonica **8**:674. 1905.=Phacelia aff. magellanica (Lam.) Coville.

7. *Hydrophyllum magellanicum albiflorum* Macloskie, op. cit. p. 674.= Phacelia aff. magellanica (Lam.) Coville.

8. *Hydrophyllum magellanicum obtusilobum* Macloskie, op. cit. p. 674. =Phacelia aff. magellanica (Lam.) Coville.

9. *Hydrophyllum magellanicum paniculatum* Macloskie, op. cit. p. 674. =Phacelia aff. magellanica (Lam.) Coville.

10. *Hydrophyllum magellanicum pinnatum* Macloskie, op. cit. p. 674. =Phacelia pinnata (Vahl) Macbr.

11. *Hydrophyllum paniculatum* Poepp. ex A. DC. Prodr. **9**:289. 1845. =Phacelia aff. magellanica (Lam.) Coville.

12. *Hydrophyllum pusillum* Muhl. ex Nutt. Trans. Philos. Soc. n. s. **5**:191. 1837, nomen in synon.=Nemophila microcalyx (Nutt.) Fisch. & Mey.

13. *Hydrophyllum tomentosum* Molina, Saggio. ed. 2. 280. 1810.=Phacelia aff. magellanica (Lam.) Coville.

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The Red Oak Complex in the United States

Ernest J. Palmer

In connection with a study of the hybrid oaks in the herbarium of the Arnold Arboretum questions have arisen as to the status of species, particularly among the red oaks of the eastern, central and southern states. The difficulty of distinguishing between some of the members of this section is generally recognized, and an examination of specimens misnamed or variously interpreted in any large collection leaves no doubt as to the confusion that exists. Some of the forms considered here have been regarded by different authorities as distinct species, varieties, forms or mere synonyms of other species and the treatment in current manuals and floras is far from uniform.

The characters generally relied upon for distinguishing the species in keys and manuals are differences in the size, shape and pubescence of the leaves, acorn cups and winter-buds. In any really distinct species at least one of these character differences should be fairly constant and it should be possible to correlate it with some of the others. But in many of the red oaks most or all of these characters seem to be extremely variable and instead of being fixed and reliable to be rather tendencies developed in different degrees and percentages. Extreme forms may appear to show good specific characters, but the examination of a large amount of material will discover many puzzling intermediates. Most keys and descriptions will be found to hold good for the typical material but to fail on intermediate forms and on many herbarium specimens that are incomplete or somewhat atypical.

Five species and several varieties of red oaks *(Coccineae)* are considered in this paper. It is not intended as a revision or final treatment, and it has not been necessary to make any new combinations. The treatment followed for the different segregates, as species or varieties is that of the second edition of Sargent's *Manual of the Trees of North America* and the second edition of Rehder's *Manual of Cultivated Trees and Shrubs*, so far as they cover the plants, with the exception of *Quercus texana*, which is here considered a variety of *Q. Shumardii*.

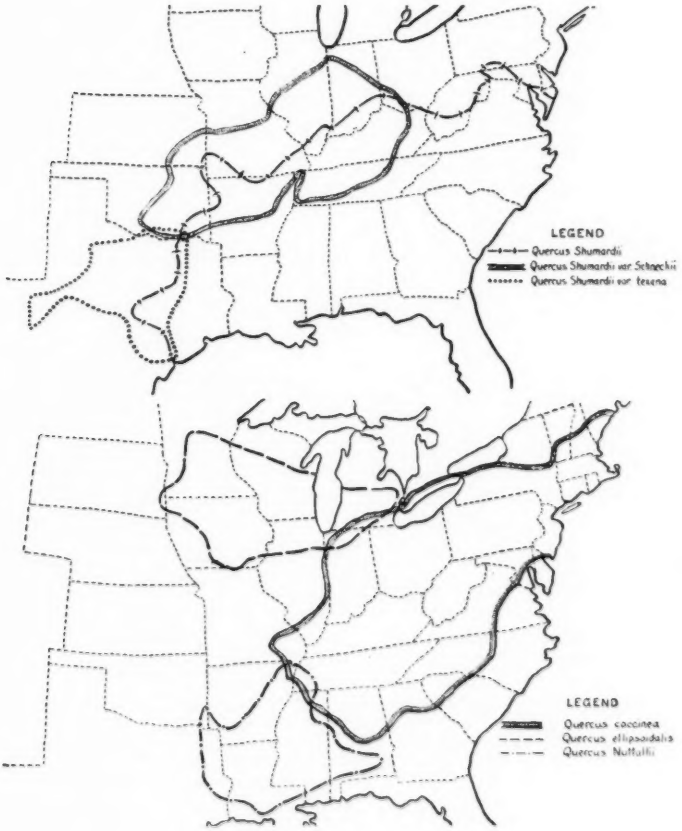
The following species and varieties are included in the key:

Quercus borealis Michx. f.
  Quercus borealis var. *maxima* (Marsh.) Ashe.
Quercus Shumardii Buckley.
  Quercus Shumardii var. *Schneckii* (Britt.) Sarg.
  Quercus Shumardii var. *texana* (Buckl.) Ashe.
  Quercus Shumardii var. *acerifolia* Palmer.
Quercus coccinea Muench.
  Quercus coccinea var. *tuberculata* Sarg.
Quercus ellipsoidalis Hill.*
Quercus Nuttallii Palmer.
  Quercus Nuttallii var. *cachensis* Palmer.

* Several forms of this species, based with one exception in differences in the acorn cup, were proposed by Trelease. But like minor forms of some of the other species, they are not important to this discussion.

Natural hybrids have been found between most of these species and it is probable that all of them are interfertile. The hybrids are not treated here, but it is obvious that a clear understanding of the species is essential to any study of hybrids between them.

The black oak (*Quercus velutina* Lam.) and the pin oak (*Quercus palustris* Muench.) have also been confused sometimes by collectors and students with some of the red oaks, but there are several characters by which they can be readily distinguished. In the field the black oak can be distinguished from all other species by its bright yellow inner bark. The large winter-buds, with grayish, pubescent scales, serve to identify it when they are well developed:



and the cups of the acorns, with their very loose, tawny, pubescent scales, are very different from those of any other species, except perhaps *Quercus marilandica,* which has distinctly different leaves. The black oak is a tree of dry or rocky upland woods.

The pin oak is usually found in wet or swampy woods or along the low border of streams or lakes. It can generally be distinguished in the field by its habit or shape. Typically, it has a straight central trunk covered with smooth, or in old trees, with slightly ridged, slaty-gray bark, and numerous slender, spreading or slightly depressed branches, forming a pyramidal, or when old, an irregular, conical crown. The short, spur-like ends of dead branchlets often persist along the branches, especially northward where the new growth is often winter-killed. The leaves are relatively small and are deeply cut. It is most often confused with *Quercus coccinea,* or with *Q. ellipsoidalis* or *Q. Nuttallii,* in the regions where those species grow, and less frequently with *Q. Shumardii* and its varieties *Schneckii* and *texana.* The small, short acorns of this species, with their shallow cups covered with very small, closely appressed scales, are so characteristic that they can scarcely be confused with those of any other species with similar foliage, except possibly with extreme forms of *Q. Nuttallii* var. *cachensis.* The small, acute, nearly glabrous winter-buds will serve to distinguish it from *Quercus coccinea,* but they are not very different from those of the other species. Where leaves alone are available, the pin oak can generally be recognized by the usually—though not invariably—cuneate base of the leaves, decurrent on the petioles, and especially by the conspicuous tufts of tomentum remaining until late in the season in the axils of the veins and often as lines along the mid-rib on the under surface.

The geographical ranges of the different species of red oaks and of some of the recognized varieties are fairly well marked, and they are a helpful check between them.* However, there are areas in which some of them overlap, and in which they are most likely to be confused. The northern red oak *(Quercus borealis)* with its poorly-marked variety *(maxima)* is the most widely distributed, ranging from southeastern Canada to North Carolina and Alabama, westward to Minnesota and the eastern parts of Nebraska, Oklahoma and Texas. In the Gulf States it is confined to the piedmont regions and along its western and southwestern limits to rocky cliffs and slopes, usually with a northern exposure. It can be recognized in the field by the practiced eye at some distance by the rather bluish-green color of the slightly drooping leaves. It is hard to understand how anyone having an acquaintance with the trees in nature, or even with herbarium specimens, can maintain *Quercus*

* The maps accompanying this paper are diagramatic and the approximate ranges shown are based upon the best available information, but it cannot be hoped that they are accurate in all details. Later discoveries may further extend the lines in some cases and in order to include some records sections are included in which the trees are seldom found. As an example, in much of the northern part of the range shown for *Quercus Shumardii* it is to be expected to occur only in scattered localities, usually along the larger rivers. Similar difficulties occur in platting the ranges of some of the other species.

borealis and *Quercus maxima* as distinct species. As in many other cases, extreme forms look distinct, but there is a complete gradation in the shape of the acorn cups, which is the only character by which they can be distinguished. In some descriptions it is stated that the acorns of *Q. borealis* are smaller than those of *Q. maxima;* but there is no correlation between the size of the acorns and the shape of the cups or between these characters and variations in the shape of the leaves that are sometimes shown in descriptions. Attempts to give different geographical ranges to the two are equally unreliable. Large-fruited and small-fruited acorns with shallow, flattened or deeper, rounded cups of all degrees and combined in all possible ways are found throughout the range of the complex. The most that can be said is that smaller acorns and rounded cups—the two characters not always associated—are relatively more frequent in the northeastern part of the range than farther south and west. But quite as typical specimens of *Quercus borealis* are occasionally found in the southern and middle states as in New England. There is evidence to indicate that the two forms do not "come true" from seeds. In a row of street trees planted near the Arnold Arboretum a complete series of variations in the size of the acorns and the shape of the cups can be found; and several trees grown in the Arboretum, supposedly from the same seed, show similar fruit variations. Throughout the range the form with shallow acorn cups, more or less flattened or depressed at the base, is by far the commonest; and it is unfortunate that the rules of priority require that the name applied to the rarer form must be taken as the specific one for the type where both are recognized as varieties or forms of one species. The facts seem to indicate that one is only an unstable form of the other.

A somewhat similar situation exists with regard to *Quercus Shumardii, Q. Schneckii* and *Q. texana,* except that their ranges are better defined geographically. All three were originally described as distinct species and they are still maintained as such by some authors. The character usually relied upon in keys for separating *Quercus Shumardii* and *Q. Schneckii* is the shape of the acorn cups, this being flattened and "saucer-shaped" in the former and rounded or "cup-shaped" in the latter. Most of the descriptions fail to bring out any other significant difference, and it is impossible to detect any in herbarium specimens. In the absence of fruit, they cannot be distinguished, except arbitrarily on geographical range. Although the resemblance in almost all respects is very close, a somewhat better case can be made for regarding them as at least distinct varieties when they are known in the field.

QUERCUS SHUMARDII is typically a tree of the coastal plain, growing in flat woods or in moist, alluvial soil along streams. It ranges from southern Pennsylvania to Florida and through the Gulf states, south of the piedmont, to south-central Texas, extending northward in the Mississippi and Ohio valleys to southern Indiana and southern Missouri. It becomes a fine large tree, sometimes 30 or 40 meters tall. The gray or brownish gray bark becomes thick and deeply furrowed on old trunks; that of the branches is smooth and often variegated with large, pale spots. The leaves on the upper branches, as noted in the original description, are sometimes more deeply divided than

those of the lower branches, but this is not always the case. This seems to be the only red oak found in Florida and over much of the Gulf coastal plain. Northward, in the middle states, it is replaced by the variety *Schneckii*, with a range from southern Ohio and Indiana to eastern Kansas and eastern Oklahoma. This oak usually grows in well drained soils on low hills or along the banks of small streams. The bark of the trunks is not so rough or deeply ridged as is that of the southern tree and it is of a uniform gray color on the branches. The leaves are more uniform on the same tree, and although they vary considerably in shape and size on both, there do not seem to be any constant differences. The acorns are generally smaller and more variable in shape in the northern tree. Individual trees that bear acorns with shallow, flatish cups, approaching those of *Quercus Shumardii* are occasionally found throughout the northern range, but the deeper, rounded form is seldom found to the southward. Specimens with deep, round or turbinate cups, that have been referred to *Quercus Shumardii* var. *Schneckii* usually turn out upon reexamination to be either *Quercus Nuttallii* or *Q. coccinea*. The trees with comparatively shallow acorn cups occasionally found in the range of var. *Schneckii* are probably only individual variants from the prevailing type, but it is difficult to prove this or to distinguish them from typical *Q. Shumardii*.

QUERCUS TEXANA Buckley has usually been maintained as a distinct species, although Ashe, once made the combination that is accepted here. The original descriptions of *Quercus Shumardii* and of *Q. texana* were published in the same paper,[3] the former appearing first on the same page. The description of the first species is clear and leaves little room for doubt as to the sort of tree it was intended to cover. It is stated that it occurs in upper Louisiana and eastern and middle Texas. In the description of *Quercus texana* no range is given, and it is somewhat disconcerting to read that it is a tree 3 to 5 feet in diameter with bark very much like that of *Q. Phellos* and *Q. aquatica (nigra)* with which it is often associated, and that the leaves are 4 to 8 inches long by 3 to 5 inches wide. However, in a later paper[4] where the author of the species reduced it to a variety of the northern red oak under the name, *Quercus rubra (borealis)* var. *texana*, he made it clear that it was the common red oak of the limestone hills of central Texas, with a range as far west as Ft. Davis. But it is equally apparent from his remarks on the distribution of the northern red oak and from his agreeing that the Texas tree was probably only a variety of it, that he did not clearly understand the difference in range and characters between the two or between them and his own *Quercus Shumardii*.

QUERCUS TEXANA, whether regarded as a species or variety, as it grows on the limestone hills of the Edwards Plateau and in the canyons and mountains further west is a handsome and distinct appearing oak. It is a small tree, seldom over 20 m. tall and usually much lower, with a short, crooked trunk, commonly branching near the base. The leaves are small, deeply cut and of a yellowish-green color; the acorns, with rounded cups varying in depth, are generally smaller than in any of the other red oaks except *Quercus ellipsoidalis* and *Q. Shumardii* var. *acerifolia*. The tree is known throughout

its range as Spanish oak, although this name has been applied to other species in different parts of the country. The habit and characters of the tree and its rather well-limited range have lent support to the idea that it is a distinct species. But, in the parts of Texas and adjacent Oklahoma where it grows, as soon as one descends into the river valleys and surrounding plains, with their richer soil, intermediate forms of more ample growth begin to appear, with the larger leaves, larger acorns and flattened cups, more or less characteristic of *Quercus Shumardii*. Besides this overlapping in range and characters with *Quercus Shumardii*, stunted trees of the variety *Schneckii* are sometimes found on the limestone glades and bald knobs of the Ozark region so closely resembling *Q. texana* that I venture to say they would be identified with it by any botanist with a knowledge of the group, if he were told that they came from Texas.

QUERCUS SHUMARDII var. ACERIFOLIA[6] is a distinct leaf form, found locally on top of Magazine Mountain, Logan County, Arkansas, where it is growing as an arborescent shrub. The small acorns resemble those of var. *texana*, although the cups are generally shallow. A number of specimens were grown at the Arnold Arboretum from seed collected at the type locality, and they have retained all of the distinctive characters. The foliage turns a brilliant red in early autumn, which also distinguishes it from other varieties.

In the coastal plain, from Alabama to eastern Texas and extending up the Mississippi Valley to the old Embayment area, another red oak is found in low wet, or even swampy, woods, in similar habitats to those of the pin oak. There is also some resemblance between the two trees in habit, in their smooth bark, and in extreme forms of the leaves. For these reasons, sterile specimens of this southern oak, *Quercus Nuttallii* Palmer, have sometimes been mistaken for the pin oak, accounting for reports of it from far beyond its true southern limits. The large acorns, with deep cups extended into a stipitate base, are so different from those of the pin oak that there is no danger of confusing the two in fruiting specimens. But there is sufficient resemblance to the acorns of the scarlet oak or of large-fruited forms of the jack oak *(Quercus ellipsoidalis)*, to have caused some collectors to mistake specimens of this southern species for one or other of them. The only other red oak found in its range and growing in low woods is *Quercus Shumardii*, with its very different fruit, and other distinctions in foliage, bark and habit. Specimens of *Quercus Nuttallii* have also been sent out as *Q. Shumardii* var. *Schneckii*, but that upland species with several characters that should readily distinguish it, does not grow within its range, except perhaps in the Mississippi Embayment area.

QUERCUS COCCINEA and Q. ELLIPSOIDALIS[5,12,14] are both somewhat intermediate between the red oaks and the black oaks, and it is natural that both of them should sometimes have been confused with *Quercus velutina* as well as with each other. The jack oak has also passed for pin oak at times because of a certain resemblance in leaf forms and in the frequent presence of the spur-like ends of dead branchlets set along the branches. The acorns of the two species are very dissimilar and the trees grow in entirely different habitats.

The ranges barely overlap in a narrow belt in Michigan, northern Indiana, Illinois and Iowa. *Quercus ellipsoidalis* is found in upland woods from the western end of Lake Erie through northern Indiana and Illinois to Wisconsin, Minnesota and Iowa, and barely into southeastern North Dakota and northern Missouri.

The scarlet oak was one of the first trees of the red oak group to attract popular attention and to be described botanically. It has been much misunderstood and has been credited with a range far beyond its real limits. The confusion with *Quercus ellipsoidalis* and with *Q. Nuttallii* has already been mentioned. Other species that have been mistaken for it are *Quercus Shumardii* and the varieties *Schneckii* and *texana*, and *Q. velutina*. Careful field study and the examination of a large amount of herbarium material shows that it extends from southern Ontario, through New England to North Carolina and the piedmont and mountainous parts of the Gulf states, and westward along the St. Lawrence River through Ohio, Indiana and southern Illinois to the granitic and sandstone areas of the Ozark region. Scattered specimens have also been found in extreme southern Michigan and on Crowleys Ridge in northeastern Arkansas. It is one of the commonest and most conspicuous oaks of New England and the northeastern states, growing usually in acid soils on dry or rocky uplands. Popular interest in its brilliant red autumn foliage has been responsible for many false reports of its occurrence as far west as Minnesota, Nebraska, Kansas, Oklahoma and Texas, as well as southward in the coastal plain. It has been customary to call any red oak with deeply cut leaves that turn red in autumn, scarlet oak. Although most trees develop a characteristic color in their autumn foliage, it is not invariable, and the color cannot always be relied upon as a specific criterion.

KEY TO THE SPECIES AND VARIETIES OF RED OAKS

Cups of acorns rounded or flattened at base with a shallow, upturned rim, usually enclosing 1/4 to 1/3 of nut; winter-buds glabrous or nearly so, narrowly conic, pointed at apex.

Mature leaves dark green or bluish green, the veins not conspicuously different in color, ovate or oblong-ovate in outline, mostly 10-18 cm. long, 8-14 cm. wide, with 3-4 pairs of wedge-shaped or oblong, mostly toothed, lateral lobes, divided by shallow or deep, divergent sinuses, glabrous on both sides at maturity, slightly drooping from the slender branchlets; winter-buds quite glabrous.

Cups of acorns rounded or bowl-shaped, thin, usually less than 2 cm. wide. Most abundant northward, but scattered throughout the range of the next and commoner variety. ..... *Q. borealis.*

Cups of acorns flattened or concave beneath about stem, shallow, thicker, usually 2-2.5 cm. wide. ..... *Q. borealis* var. *maxima.*

Mature leaves bright or yellowish green, the pale or nearly white veins conspicuous, ovate elliptic or oblong-ovate in outline, with 2-3 or rarely 4 pairs of oblong or oblong-obovate, lateral lobes, the middle or larger ones often again divided toward the widened apex and ending in several bristle-tipped teeth, the main lobes divided by convergent or divergent sinuses, glabrous above and glabrous beneath except for tufts of tomentum in the axils of the principal veins; winter-buds glabrous or sometimes with the upper scales puberulous

or finely ciliate at apex. Leaves spreading, somewhat clustered at the ends of the branchlets.

Leaves relatively small, mostly 7-12 cm. long and wide (sometimes larger on new growth), with 2-3 pairs of cuneate, oblong or obovate, entire or toothed, lateral lobes, the upper sinuses usually, but not always, divergent; acorns 1-2.5 cm. long, the nut 1/3 to 2/5 enclosed in the thin, bowl-shaped cup. Small trees or arborescent shrubs, seldom over 20 m. high.

Leaves abruptly narrowed or truncate at base, slightly longer than wide or rarely isometric. Rocky, usually limestone, hills, central and southwestern Texas and adjacent Oklahoma. ..... *Q. Shumardii* var. *texana.*

Leaves truncate or cordate at the broad base, mostly as wide or often wider than long. Local in central Arkansas. ..... *Q. Shumardii* var. *acerifolia.*

Leaves relatively large, mostly 9-16 cm. long, 7-14 cm. wide, with usually 3, or rarely 2 or 4, pairs of lateral lobes; acorns mostly 2-3 cm. long, the nut 1/4 to 1/3 enclosed in the flattened or rounded cups. Large trees up to 30-40 m. tall.

Leaves on upper branches of old trees often more deeply divided than on the lower branches; cups of acorns shallow, flattened or concave beneath, usually 2-2.7 cm. wide, enclosing about 1/4 of nut, the lower series of scales thickened and often tuberculate at base. Low or alluvial woods, coastal plain. ..... *Q. Shumardii.*

Leaves essentially uniform on upper and lower branches; cups of acorns rounded or bowl-shape, usually 2 cm. or less wide, enclosing 1/3 to 2/5 of nut, or sometimes shallower and nearly flat at base, the scales thin, closely appressed and not tuberculately thickened at base. Upland woods and bluffs along small streams. Central States and Mississippi Valley..... ..... *Q. Shumardii* var. *Schneckii.*

Cups of acorns bowl-shaped or top-shaped with a stipe-like base, usually enclosing 1/3 to 1/2 of nut; leaves deep green, the veins not conspicuously paler, the blades deeply divided by usually convergent sinuses into 2-3 pairs of lateral lobes, the larger ones widened and subdivided or toothed above, glabrous on both sides except sometimes for small, inconspicuous tufts of tomentum in the axils of the veins beneath.

Leaves oblong- obovate or elliptic in outline, abruptly contracted or truncate at base; winter-buds conic-ovoid, obtuse or rounded at apex, the upper scales conspicuously pubescent on margins.

Acorns usually 2-2.5 cm. long, tthe cups 2-2.3 cm. wide, their scales not tuberculately thickened at base. ..... *Q. coccinea.*

Acorns usually 2.5-3 cm. long, the cups about as wide as length of nut, conspicuously tuberculate from the much thickened bases of the lower scales. ..... *Q. coccinea* var. *tuberculata.*

Leaves obovate, oblong-obovate, or rhombic in outline, mostly abruptly or narrowly cuneate and attenuate at base; winter buds pointed, the upper scales inconspicuously ciliate-pubescent or nearly glabrous.

Leaves mostly oblong-obovate in outline, abruptly narrowed or rarely truncate at base; acorns usually distinctly longer than wide, narrowed at both ends, with top-shaped cups rarely over 1.5 cm. wide. ..... *Q. ellipsoidalis.*

Leaves mostly obovate or rhombic-obovate in outline, abruptly or narrowly cuneate and often attenuate at base; acorns oblong-ovoid with rounded or bowl-shaped cups.

Acorns 2-3 cm. long, the nuts longer than thick, 1/3 to 1/2 enclosed in cup. ..... *Q. Nuttallii.*

Acorns 1.5-2 cm. long and about as thick, the cups enclosing 1/3 or less of the short-oblong nut. ..... *Q. Nuttallii* var. *cachensis.*

The variable and unstable character of several of the red oaks considered here suggests that in some cases—particularly in that of *Quercus Shumardii* and its varieties—we are dealing with incipient species or with a complex of various forms of one polymorphic species, all derived from a common and not very remote ancestral type that became widely dispersed in eastern and central North America, and that several segregates are now in process of development in different parts of the range under more or less diverse ecological conditions.

Some of the oaks of the section *Coccinae* are among the most difficult of all the species in the region to describe and distinguish; but it should be recognized that all of the oaks, as well as many other plants, are variable and not standardized organisms. No key or description can be drawn up that will cover all of the possible variations and forms. It is only by studying the living trees and taking note of all their characters, variations and environments, as well as by the more minute examination of herbarium specimens, that the student can come to know and distinguish them with some degree of certainty.

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ARNOLD ARBORETUM,
JAMAICA PLAINS, MASS.

The Genus Polemonium in America

Edgar T. Wherry

Although devoting most attention to *Phlox*, the writer is often called upon for identifications of other members of the *Polemoniaceae*, and of these the species of *Polemonium* have proved especially difficult. A study of the genus has accordingly been undertaken.

From the series of names used for these plants in earlier days, Linnaeus[1] selected Tournefort's *Polemonium*, and in 1753 proposed three species: *P. caeruleum*, the only one retained in the genus today; *P. dubium*, now classed as a *Phacelia*; and *P. rubrum*, later recognized by Linnaeus[2] himself as belonging to another genus, and subsequently placed in *Gilia* or *Ipomopsis*.

During the succeeding 75 years a number of other species were announced, but in many cases the diagnoses were inadequate, and in 1828 Lindley[3] remarked that "the whole genus and order are in a miserable state of confusion; and it is not worth while beginning to reform them, without completing the task, — for which we have neither leisure nor material." Attempts to reform the genus *Polemonium* were subsequently made, notably by Bentham,[4] Gray[5] and Brand,[6] but its "state of confusion" is still pretty miserable.

Like Lindley, the present writer does not have the leisure to complete the reformation of this wayward genus, which will involve extensive cultural and cytogenetic studies.[7] A step in that direction has been taken, however, in that the data concerning all the American species have been assembled, and an artificial key prepared which will identify 90% of an average lot of specimens. This key is here published, along with an annotated list of the names included and excluded, in the hope that it will aid other workers in identifying their material, as well as serve as a basis for further revision in the future.

Certain nomenclatorial procedures which are followed require brief discussion. Species names are uniformly decapitalized; for, as stated in Art. 15 of International Rules (1930), "The purpose of giving a name to a taxonomic group is not to indicate . . . the history of the group." Since current usage is to place infraspecific epithets in the same gender as the genus, the ending -a, used by certain authors in a few cases, is replaced by -um. And the spelling of some epithets derived from personal names is changed slightly.

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1 Species Plantarum: 162. 1753.
2 Select. Corresp. Linn., by J. E. Smith **1**:274. 1821.
3 In Edwards' Bot. Reg. **15**: pl. 1303. 1830.
4 In De Candolle's Prodromus **9**:316. 1845.
5 Proc. Amer. Acad. Arts Sci. **8**:280. 1870.
6 In Engler's Pflanzenreich IV. **250**:30. 1907.
7 Preliminary work along the latter line has been done by Ostenfeld, Dahlgren and Clausen, Hereditas **4**:17. 1923; **5**:17. 1924; **12**:33. 1929; **15**:62. 1931.

The taxonomic plans followed here also call for explanation. Two categories of infraspecific rank are recognized: Subspecies (termed by Bentham *l. c.* "variety" and assigned a greek letter) in which the plants concerned are rather different morphologically and/or geographically, yet exhibit marked intergradation or overlapping; and form (termed by Gray *l. c.* "variety") comprising variants in which the morphologic features involved are superficial, and there is no geographic segregation at all.

Some taxonomists contrast infraspecific entities with the original species from which they have been segregated; this procedure is, however, illogical, in that a whole object can not be coördinate with a part of itself. "People have more fun than anybody" may serve as a slogan of a radio-comedian, but is not taxonomically sound. Once a subspecies, variety, or form is separated, the remainder automatically becomes the typical representative of the same category, and should be named correspondingly.

In the following list, new names and combinations are indicated by boldface type, names from the literature which are accepted by italic, and discarded names by light-face roman type. Abbreviated references are added after the names of authors of epithets, comprising: title of publication, volume, colon, page-number, comma, and year. Brand's Monograph is abbreviated to "Pol."; its full reference is: Polemoniaceae, in Engler's Pflanzenreich IV. **250**:1-203, 1907.

Names Applied to American Polemoniums

acaule Schiede ex M. & G. Bull. Ac. Brux. 12(2): 277, 1845. A Mexican *Phacelia.*

achilleaefolium Willd. ex R. & S. Syst. 4: 793, 1819. Another Mexican *Phacelia.*

acutiflorum Willd. ex R. & S. Syst. 4: 792, 1819. Considered by Brand Pol.: 38, 1907, to be identical with "P. villosum" Rud. ex Georgi Beschr. Russ. Reichs (3)4: 771, 1800, but that was a nomen nudum and is best ignored. Ledebour Fl. Ross. 3: 84, 1847, made it a subspecies of *P. caeruleum* L., but Hultén Fl. Kamch. 4: 72, 1930, maintained its specific distinctness. Besides its typical tall form, there is a well-marked dwarf one.

albiflorum Eastw. Bot. Gaz. 37: 437, 1904. Made *P. foliosissimum* Gray ssp. *albiflorum* by Brand Pol.: 34, 1907, and he is followed here.

album Fisch. Zus. Naturg. Livl.: 109, 1784. Being a mere albino, this may be known as *P. caeruleum* L. **f. album** (Fisch.) W., stat. nov.

amoenum Piper Erythea 7: 174, 1899. Reduced to *P. carneum* Gray ssp. *amoenum* by Brand Pol.: 41, 1907, which is here accepted. The status was changed to forma by Jones Univ. Wash. Publ. Bot. 5: 215, 1936, but both morphologic and geographic differences are too marked to justify this.

antarcticum Griseb. Goett. Abh. 6: 131, 1854. A species of *Polemoniella.*

archibaldae Nels. Bot. Gaz. 31: 397, 1901. Made by Brand Pol.: 37, 1907, a variety of *P. filicinum* Greene, but not closely related to that. It is here referred in another status to the species from the typical representative of which it differs only in sparser pubescence and exserted styles: *P. foliosissimum* Gray **ssp. archibaldae** (Nels.) W., stat. nov.

berryi Eastw. Bot. Gaz. 37: 440, 1904. Made by Brand Pol.: 36, 1907, a variety of "P. pulcherrimum ssp. parvifolium," but here kept as a species.

bicolor Greenm. Bot. Gaz. 25:262, Apr. 15, 1898; *P. elegans* Greene Pitt. 3: 305, Apr. 8, 1898, one week's priority! Since not based on the same type specimen, these two names can not be classed as synonyms; the later published one should be placed in some infraspecific status under the earlier. This may well be: *P. elegans* Greene **f. bicolor** (Greenm.) W., stat. nov. Differs from the typical form in being somewhat more lax.

biflorum (R. & P.) O. Ktze. Rev. Gen. 3(2): 202, 1898.=*Collomia biflora* Brand.

boreale Adams Mem. Soc. Nat. Mosc. 5: 92, 1817. Made by Brand Pol.: 40, 1907, a subspecies of "P. lanatum" Pallas Reise Russ. Reichs 3: 33, 1776, but this was a nomen nudum, and is accordingly invalid. The original plant is here named *P. boreale* Adams **ssp. genuinum** W., nom. nov.

brandegeei (Gray) Greene Pitt. 1: 126, 1887. The original representative of this species may be known as **ssp. typicum** W., nom. nov. It has two color-forms, the typical form ("Gilia Brandegei" Gray Proc. Am. Ac. 11: 85, 1876) with the corolla "golden-yellow"; and **f. lambornii** (Gray) W., stat. nov. ("Gilia Brandegei var. Lambornii" Gray Syn. Fl. 2(1): 149, 1878; "Polemonium Brandegeei var. Lambornii" Brand Pol.: 45, 1907) with corolla "lurid-yellowish or greenish."

bursifolium Willd. ex R. & S. Syst. 4: 793, 1819. A *Eutoca* from Mexico.

caeruleum L. Sp. Pl.: 162, 1753. Some authors change the original spelling to "coeruleum," but this seems unjustified.

caeruleum β L. *l. c.* (misprinted α.) =*P. boreale* Adams.

caeruleum γ L. *l. c.* Raised to species rank by Linnaeus himself six years later, as *P. reptans*.

caeruleum α Hook. Fl. Bor. Am. 2: 71, 1838. =*P. occidentale* Greene; Brand.

caeruleum campanulatum Fries Bot. Not. 1858: 190. =*P. acutiflorum* Willd.

caeruleum var. foliosissimum Gray Proc. Am. Ac. 8: 270, 1870. Later raised to species rank by Gray himself Syn. Fl. 2(1): 151, 1878.

caeruleum genuinum Cham. Linnaea 6: 551, 1831. Earliest name in var. status for the original Linnaean plant.

caeruleum var. gmelini Cham. *l. c.* =*P. boreale* Adams.

caeruleum β humile Hook. Fl. Bor. Am. 2: 71, 1838. =*P. richardsoni* Graham.

caeruleum var. humile (Willd.) Kurtz Engl. Bot. Jahrb. 19: 399, 1895. The same as *P. pulcherrimum* Hook.

caeruleum var. humile f. pulchellum (Bunge) Kurtz *l. c.* A complex of several American dwarf species.

caeruleum var. nanum Hook. Tr. Linn. Soc. 14: 377, 1825. (as "nana"). Proposed for a series of dwarf species, including *P. richardsoni* Graham.

caeruleum ovatum grandiflorum Ledeb. Fl. Ross. 3: 84, 1847. =*P. boreale* Adams.

caeruleum var. piliferum Lindl. Edw. Bot. Reg. 15: pl. 1303, 1830. Identical with *P. richardsoni* Graham.

caeruleum δ? pterospermum Benth. in DC. Prodr. 9: 317, 1845 ("coeruleum, pterosperma"). The basis for *P. occidentale* Greene; Brand Pol.: 33, 1907.

caeruleum γ pulcherrimum Hook. Fl. Bor. Am. 2: 71, 1838. =*P. pulcherrimum* Hook. Bot. Mag. 57: Pl. 2979, 1830. In making this reduction in status, Hooker (who seems never to have obtained a clear idea of the distinctive features of members of the *Polemoniaceae*) summed up the attitude of the "lumper" so well that he deserves to be quoted: "Few plants are more variable, and few more extensively distributed in the temperate and colder regions of the northern hemisphere, than the present; from Kamoon and Kolghur, in Northern India, to Spitzbergen and the Arctic sea-shores of Europe, Asia, and America. I have long hesitated whether or not I should consider the var. γ as distinct from the true *caeruleum*, but I fear it presents no valid points of difference. The species is met with of all sizes, in all states of hairiness, and with all sizes of the flower."

caeruleum α vulgare Ledeb. Fl. Ross. 3: 83, 1847. The earliest name in subspecies status for the original Linnaean plant; Brand Pol.: 38, 1907.

californicum Eastw. Bot. Gaz. 37: 437, 1904. Regarded by Brand Pol.: 35, 1907, as identical with "P. pulcherrimum delicatum," but kept as a species here. It is highly variable, and some variants may deserve subspecies rank.

calycinum Eastw. Bot. Gaz. 37: 438, 1904. Reduced by Brand Pol.: 35, 1907, to a variety of "P. pulcherrimum ssp. delicatum," but decidedly distinct.

campanulatum Fries Bot. Not. 1858: 190, as a subspecies of *P. caeruleum* L. Informally raised to species status by Norrlin Not. Selsk. Fenn. 13: 258, 1871. Probably a form of *P. acutiflorum* Willd. ex R. & S.

candidum Sess. & Moc. Fl. Mex.: 42, 1893. A *Gilia* from Mexico.

capitatum Esch. Mem. Ac. St. Pet'g. 10: 282, 1826. A *Gilia* from California.

capitatum Benth. in DC. Prodr. 9: 317, 1845. =*P. richardsoni* Graham.

carneum Gray Syn. Fl. 2(1): 151, 1878. Divisible into two subspecies: *genuinum* Brand Pol.: 41, 1907,with relatively few large leaflets and lavender to yellow flowers, s. Wash. - Calif.; and *amoenum* (Piper) Brand *l. c.* with more numerous smaller leaflets and violet flowers, Wash. only. The yellow color-form of ssp. *genuinum* was made a variety ("luteum") by Gray Syn. Fl. (ed. 2) Suppl.: 412, 1886, an independent species by Howell Fl. NW. Am. 1(4): 463, 1901, and another subspecies by Brand *l. c.* Here it is not regarded as deserving higher rank than form (cf. p. 748). The species name was erroneously spelled "incarnatum" on labels accompanying plants distributed by Greene, as published by Hook. Bot. Mag. 113: pl. 6965, 1887.

chartaceum Mas. apud Jeps. Man. Fl. Pl. Calif.: 783, 1925. This differs in few respects from *P. eximium* Greene, but may well be specificially distinct.

ciliatum Willd ex R. & S. Syst. 4: 792, 1819. =*Phacelia purshii* Buckl.; discussed by the writer Bartonia 18: 52, 1936.

coeruleum. A variant spelling of *caeruleum*, apparently first used by Willd. Enum. 2, suppl.: 10, 1813.

columbianum Rydb. Bull. Torr. Bot. Club 40: 477, 1913. A species of the northwestern states, included by Brand Pol.: 35, 1907, under "P. pulcherrimum ssp. delicatum," as shown by citations of Wash. and Ore. specimens.

confertum Gray Proc. Ac. Nat. Sci. Phila. 1863: 73. The material on which var. α of this was founded, Hall & Harbour No. 450, comprised two species: one with leaflets at most 6 and often only 3 mm. long, the other with many leaflets 10 and a few up to 15 mm. long. A plant of each is present on Gray's type sheet, and he made his diagnosis cover both: "foliolis 1½-5 lin. longis" or in metric terms 3-10 mm. long. The small-leaved species concerned, as pointed out by Rydberg Bull. Torr. Bot. Club 24: 252, 1897, is what Nuttall J. Ac. Nat. Sci. Phila. (2) 1: 154, 1848, had named *P. viscosum*. This point was missed by Gray because the specimen in his herbarium supposed to represent the type of *P. viscosum* Nutt. is spurious, as will be further explained in the discussion of that species, below. Rydberg *l. c.* accordingly restricted the name *P. confertum* to the element with large-sized leaflets, so its authorship should be given as:

confertum Gray; Rydb. Bull. Torr. Bot. Club 24: 252, 1897. Accepted species.

confertum mut. albiflorum Ckl. Torreya 13: 270, 1913. The type specimen of this represents *P. viscosum* Nutt. f. *leucanthum* L. Wms.

confertum var. elatius Brand Pol.: 44, 1907. This is the plant selected by Rydberg to bear the name *confertum*, so if a varietal name is ever needed for it, "typicum" or an equivalent should be used.

confertum var. mellitum Gray Proc. Ac. Nat. Sci. Phila. 1863: 73; raised to species rank by Nelson Bull. Torr. Bot. Club 26: 354, 1899. It actually differs from the typical representative of another species only in slightly declined stamens, — a relation noted by Gray Proc. Am. Ac. 11: 85, 1876 but interpreted as a generic (!) distinction — so deserves subordinate rank under that: *P. brandegeei* (Gray) Greene **ssp. mellitum** (Gray) W., stat. et comb. nov.

crassifolium (Benth.) O. Ktze. Rev. Gen. 3(2): 203, 1898. A. *Gilia*.

decurrens Brand Rep. Sp. Nov. 17: 316, 1921. Not here regarded as specifically distinct, so placed in the combination: *P. foliosissimum* Gray **ssp. decurrens** (Brand) W., stat. nov. Differs from the typical subspecies in larger leaflets, white corollas, and somewhat longer styles.

delicatum Rydb. Bull. Torr. Bot. Club 28: 29, 1901. Made by Brand Pol.: 35, 1907, "P. pulcherrimum ssp. delicatum," but here retained as a species. The data in the literature as to the leaflet-length in this plant constitute such a good illustration of the confusion one encounters in attempting to interpret Polemoniums that they may well be quoted: 3-10 mm. Rydb. *l. c.*; 10-20, rarely 30, Brand *l. c.*; 5-15, Rydb. Fl. Rocky Mts.: 680 (key); 3-10, ibid: 681 (text) 1917. Here the original species is termed *P. delicatum* Rydb. **ssp. typicum** W., nom. nov.; its characteristic feature is: length of principal leaflets 7-10 mm.

drummondii (Hook.) O. Ktze. Rev. Gen. 3(2): 203, 1898. = *Phlox drummondii* Hook.

dubium L. Sp. Pl.: 163, 1753. = *Phacelia dubia* Trelease.

ehrenbergii Brand Pol.: 41, 1907. Accepted as a species.

elatum Salisb. Prodr.: 125, 1796. An illegitimate name, being expressly substituted for *P. caeruleum* L.

elegans Greene Pitt. 3: 305, 1898. This name antedates "P. bicolor" Greenm. Bot. Gaz. 25: 262, 1898, by one week; they are forms of the same species. Brand Pol.: 44, 1907, inaptly made it a subspecies of *P. viscosum* Nutt.

eximium Greene Pitt. 3: 305, 1898. Here accepted as an independent species. It was reduced to a variety of "P. confertum Gray" by Jepson Man. Fl. Pl. Calif.: 783, 1925, but differs markedly from both components of that.

fasciculatum Eastw. Bot. Gaz. 37: 442, 1904. Made by Brand Pol.: 36, 1907, a variety of *P. rotatum* Eastw., but as brought out in the key, seems worthy of being maintained as distinct.

filicinum Greene Pitt. 1: 124, 1887. Generally accepted as a valid species, although its differences from *P. foliosissimum* Gray are rather slight.

flavum Greene Bot. Gaz. 6: 217, 1881. A well-marked species of the southwest.

flavum Hook. Bot. Mag. 113: pl. 6965, 1887; not *P. flavum* Greene. The colored plate, description, and locality given show this to represent the Mexican plant later named *P. luteum* by Greene Pitt. 4: 100, 1899.

foliosissimum Gray Syn. Fl. 2(1): 151, 1878; previously named by Gray Proc. Am. Ac. 8: 281, 1870, as a variety of *P. caeruleum* L. Proposed to include material collected by "Geyer, Fendler, Parry, Vasey, Watson, etc." The sheets referred to, preserved in the Gray Herbarium, bear a rather diverse lot of plants, not all conspecific; Gray failed to designate any one of them as the type. The original description included the diagnostic characters: "valde viscido-pubescens . . . corymbosis . . . floribus minoribus . . . staminibus styloque corolla . . . saepius brevioribus." Two of the plants, Geyer No. 530 and Watson No. 933, have decidedly exserted styles, accounting for Gray's introducing the "saepius" before "brevioribus;" a third, Vasey No. 443, has rather large flowers in a subthyrsoid inflorescence. Both of the others, Fendler No. 645 and Parry No. 275, fit Gray's description closely; as the latter came from a fairly definite part of Colorado "Headwaters of Clear Creek . . ." it is herewith made the lectotype. In spite of the fact that all five specimens cited have violet flowers, Gray on raising the plant to species status characterized it as having the "corolla commonly white or cream color, sometimes violet." On the other hand, Rydberg Fl. Rocky Mts.: 680, 1917, placed the species under the key-heading "Corolla purple" and in the text op. cit.: 682 described it as "blue or rose colored, rarely white." Field and herbarium study indicate that Rydberg's estimate of the relative abundance of deep and pale-colored corollas is the correct one, although the hue represented is preferably termed violet. The original plant is herewith designated *P. foliosissimum* Gray **ssp. verum** W., nom. nov.

foliosissimum ssp. *albiflorum* (Eastw.) Brand Pol.: 34, 1907. A representative of the species with narrow leaflets, white flowers and exserted styles.

foliosissimum albiflorum var. alpinum Brand Pol.: 34, 1907. Described as having more numerous leaflets and more appressed cauline leaves than the original *albiflorum;* as the leaves have merely become appressed in press, it is unworthy of nomenclatorial recognition.

gayanum (Wedd.) Brand Pol.: 46, 1907. A *Polemoniella* from S. Am.

gracile Dougl. ex Lindl. Edw. Bot. Reg. 15: pl. 1304, 1830. A nomen nudum, apparently representing one of the dwarf arctic-American species. It is not "P. gracile" Fisch. Hort. Gorenki (ed. 2): 28, 1812, which was a slender-leaflet European form of *P. caeruleum* L.

grande Greene Leafl. Bot. Obs. 1: 153, 1905. Classed by Brand Pol.: 37, 1907, (on the advice of Nelson) as identical with "P. archibaldae" Nels., which Brand made a variety of *P. filicinum* Greene. Here kept in species status.

grandiflorum Benth. in DC. Prodr. 9: 317, 1845. A well-marked species.

grayanum Rydb. Bull. Torr. Bot. Club 31: 635, 1904. An endemic with fair differentiating characters; the calyx-length is, however, not one of these, for the value "18 mm." given in the original description proves on study of the type specimen to have been a misprint for 13 mm. Although Brand Pol.: 44, 1907, made it a variety of *P. viscosum* Nutt. and Nelson New Man. Bot. R. Mts.: 405, 1909, reduced it to full equivalence with that, it is here maintained as a distinct species.

haydeni Nels. Bull. Torr. Bot. Club 26: 353, 1899; authorship erroneously ascribed to Heller in Index Kewensis, Suppl. II. This was reduced by Brand Pol.: 35, 1907, to "P. pulcherrimum parvifolium var. haydeni," but is so distinct from the other two plants as to deserve species standing.

helleri Brand Pol.: 32, 1907. A species with unusually short corolla.

hinckleyi Standl. Am. Midl. Nat. 18: 684, 1937. This plant is a close relative of *P. pauciflorum* Wats. Proc. Am. Ac. 23: 280, 1888, differing from the original material of that only in being less pubescent and having slightly longer sepals. New status is therefore proposed for it here: *P. pauciflorum* Wats. **ssp. hinckleyi** (Standl.) W., stat. nov.

humile Salisb. Prodr.: 125, 1796. Although this is an illegitimate synonym of *P. reptans* L., its proposal precludes the use of the epithet for any of the species to which various authors have subsequently applied it.

humile Willd. ex R. & S. Syst. 4: 792, 1819. The specimen in the Willdenow herbarium was considered by Kurtz Engl. Bot. Jahrb. 19: 399, 1895, to be *P. pulcherrimum* Hook.; by Brand Pol.: 40, 1907, *P. richardsoni* Graham.

humile Lindl. Edw. Bot. Reg. 15: pl. 1304, 1830. Regarded as a distinct species, which is named below (p. 748) in honor of Lindley.

humile macranthum Cham. Linnaea 6: 552, 1831, is herewith made: *P. boreale* Adams **ssp. macranthum** (Cham.) W., comb. nov. Leaflets relatively large.

humile var. pulchellum Gray Syn. Fl. 2(1): 150, 1878. Not *P. pulchellum* Ledeb. Ic. Pl. Ross. 1: 6 & pl. 20, 1829; Bunge Fl. Alt. 1: 233, 1829. Gray furnished data which suggest that he intended the name to cover about all the small-flowered species of North America.

incarnatum Greene ex Hook. Bot. Mag. 113: pl. 6965, 1887. A clerical error for *P. carneum* Gray.

incisum (Benth.) O. Ktze. Rev. Gen. 3(2): 203, 1898. =*Gilia incisa* Benth.

intermedium (Brand) Rydb. Bull. Torr. Bot. Club 40: 478, 1913. Originally named "P. occidentale var. intermedium" Brand Pol.: 33, 1907, but deserves species status.

laciniatum (R. & P.) O. Ktze. Rev. Gen. 3(2): 203, 1898. =*Gilia laciniata* R. & P.

lanatum Pallas Reise Russ. Reichs 3: 33, 1776; a nomen nudum. Brand Pol.: 39, 1907, treated this name as valid, citing the existence in the Berlin herbarium of an unpublished plate. He failed to designate a typical subspecies, but made "boreale" and "pulchellum" subspecies, and "humile" a variety under it. Here the earliest properly published name, *P. boreale* Adams Mem. Soc. Nat. Mosc. 5: 92, 1817, is accepted for the plant.

lemmonii Brand Pol.: 44, 1907. In his key to Section *Melliosma* Pol.: 43, 1907, Brand gave as the diagnostic character of this "filaments scarcely longer than anthers," in contrast to *P. viscosum* Nutt. which was said to have "filaments much longer than anthers." The situation here is puzzling; among specimens collected from the type locality, San Francisco mountains, Arizona, the adnation of the filaments varies from only slight to nearly complete. Similar variation occurs elsewhere in Arizona as well as in southwestern Colorado. Since the plants are otherwise indistinguishable, at most subspecies segregation seems acceptable, as follows: *P. viscosum* Nutt. **ssp. lemmonii** (Brand) W., stat. nov. Comprising plants with the filaments adnate to the corolla-tube for over 2/3 their length.

lindleyi W. nom. nov. Proposed to replace "P. humile" Lindl. Edw. Bot. Reg. 15: pl. 1304, 1830; not "P. humile" Salisb. Prodr.: 125, 1796, nor "P. humile" Willd. ex R. & S. Syst. 4: 792, 1819. Plant to 25, or in cultivation to 40 cm. high, the stems divergently branched; pubescence sparse, glandular only upward, scarcely odorous; leaves to 20 cm. long with up to 17-23 leaflets, all free or at most the terminal 3 confluent, narrow to broad-elliptic, to somewhat ovate or obovate, acutish to obtusish, up to 12 mm. long; inflorescence a panicle of small cymes; sepals about 7 mm. long, united to 1/2 - 3/5 their length, the free portions deltoid-oblong, acutish; corolla campanulate with rotate limb, to 15 mm. long and when expanded 20 mm. across, light violet with yellow eye; stamens moderately zygomorphic, divergent, the anthers yellow, included in the closed corolla; styles united to within 1½ mm. of the tips, also included. Originally described on plants raised from seed collected by Richardson in arctic America; the data given above were obtained on material now in cultivation from stock obtained by Mrs. J. Norman Henry at Telegraph Creek, B. C.

luteum Greene Pitt. 4: 100, 1899. A well-marked Mexican species. It had earlier been figured by Hook. Bot. Mag. 113: pl. 6965, 1887, but he did not realize that it was an as yet undescribed species, and mistakenly referred it to *P. flavum* Greene. Brand Pol.: 41, 1907, made it a variety of *P. grandiflorum* Benth. but it is not here followed.

luteum (Gray) Howell Fl. NW. Am. 1(4): 463, 1901. This is the color-form of *P. carneum* Gray Syn. Fl. 2(1): 151, 1878, first named "var. luteum" by Gray ibid (ed. 2). Suppl.: 412, 1886. Brand Pol.: 41, 1907, placed it in subspecies status, but from our present viewpoint it deserves to be classed merely as: *P. carneum* Gray **f. luteum** (Gray) W., stat nov. Color more or less yellow instead of flesh-color as in the typical form.

mellitum (Gray) Nels. Bull. Torr. Bot. Club 26: 354, 1899; erroneously ascribed to Heller in Ind. Kew. Suppl. II. Above (p. 745) classed as *P. brandegeei* (Gray) Greene ssp. *mellitum* (Gray) W. It can scarcely be distinguished in average herbarium specimens from the typical subspecies of *P. brandegeei*.

mexicanum Cerv. ex Lag. Gen. & Sp.: 10, 1816. A well-marked species.

mexicanum Nutt. J. Ac. Nat. Sci. Phila. 7: 41, 1834. Subsequently Nuttall discovered that this name was preoccupied, and on his herbarium labels changed it to "parvifolium." He neglected to publish this, but that was done by Rydberg Bull. Torr. Bot. Club 24: 253, 1897. However, both Nuttall and Rydberg overlooked the fact that much the same plant had previously been named *P. pulcherrimum* by Hooker Bot. Mag. 57: pl. 2979, 1830. The Nuttall-Rydberg name is accordingly reduced in status below (p. 751).

micranthum Benth. in DC. Prodr. 9: 318, 1845. = *Polemoniella micrantha* Hlr.

molle Greene Leafl. Bot. Obs. 1: 153, 1905. Made by Brand Pol.: 34, 1907, a synonym of *P. foliosissimum* Gray ssp. *robustum* (Rydb.) Brand, but actually close to ssp. *verum* W. As it differs from the typical form of the latter only in the slightly larger corolla, it may well be known as *P. foliosissimum* Gray **f. molle** (Greene) W., stat. nov.

montrosensis Nels. Proc. Biol. Soc. Wash. 18: 174, 1905. Brand Pol.: 35, 1907, considered this equivalent to "P. pulcherrimum parvifolium var. haydeni." It is not closely related to the third of these, but differs from *P. pulcherrimum* Hook. Bot. Mag. 57: pl. 2979, 1830, only in having somewhat more numerous leaflets (maximum number 27 vs. 23), so is here reduced in rank to: *P. pulcherrimum* Hook. **f. montrosense** (Nels.) W., stat. nov. A similar plant was named P. tevisii Eastw. in 1904.

morenonis O. Ktze. Rev. Gen. 3(2): 203, 1898. = A *Microsteris*.

muricatum Lag. ex Schrank Syll. Ratisb. 1: 199, 1824, is apparently not a member of the genus *Polemonium* at all.

(Nevada plant): In the U. S. National Arboretum Herbarium there is a specimen from Hinkey Summit, East Cliffs, 8200', Santa Rosa range, Humboldt Co., Nevada, which has the leaflets verticillate as in the *P. viscosum* group, but the flowers small with corolla campanulate-rotate as in the *P. reptans* group. Whether it is an independent species or a mere mutant of *P. delicatum* Rydb., which it resembles in most respects, can not be decided until more material is available, so it is not named here.

nyctelea L. Sp. Pl. (ed. 2): 231, 1762. = An *Ellisia (Hydrophyllaceae)*.

occidentale Greene Pitt. 2: 75, 1890. In proposing the name Greene stated: "I thus name and define as a probable species the '*P. coeruleum*' of the Rocky Mountains of Colorado, and of the California Sierras, not doubting that the rare plant of the northern Atlantic states catalogued everywhere as *P. coeruleum* will be found identical with this when its characters shall have been taken note of." The name is thus scarcely valid, in that it was put forward provisionally only, and was based on two discordant elements, the western and eastern plants respectively. It was, however, later validated as follows:

occidentale Greene; Brand Pol.: 33, 1907. Name validated by referring it to the plant earlier announced as "P. caeruleum δ? pterosperma" Benth. in DC. Prodr. 9: 317, 1845, which was based on a specimen collected by Drummond "in the mountains of western North America." As Drummond is known to have crossed these mountains in southern British Columbia, the type locality is approximately fixed. Two years before, Brand Helios 22: 77, 1905, had urged that Bentham's varietal name should be used in species status, temporarily overlooking the previous publication of *P. pterospermum* Nels. & Ckl. Proc. Biol. Soc. Wash. 16: 45, 1903, for an entirely different species. The original plant may be known as *P. occidentale* Greene; Brand **ssp. typicum** W., nom. nov.

occidentale Greene; Brand **ssp. amygdalinum** W., nova. Stem 15-25 cm. high; leaves much reduced; inflorescence subcapitate; flowers exhaling an odor resembling oil of bitter almonds (nitrobenzene), whence the name; otherwise as in ssp. *typicum*. (Caulis 15-25 cm. altus; folia minora; inflorescentia subcapitata; flores odore amygdalino; caetera ut in subspecie typica.) Type in herbarium Academy Natural Sciences Philadelphia, collected by W. N. Suksdorf in alpine meadows on Mt. Adams, Washington, 8/30/'81. Seen on the south slope at 7000′ elevation by the writer in 1931; known thus far only from this mountain, although intermediates between it and ssp. *typicum* are occasional throughout the species range.

occidentale var. intermedium Brand Pol. 33: 1907; appropriately raised to species status by Rydberg Bull. Torr. Bot. Club 40: 478, 1913.

orbiculare Gand. Bull Soc. Bot. France 65: 58, 1918. Based on a specimen collected by Scheuber in the Bridger Mountains, Montana. Material in American herbaria represents a variant differing from the typical form of *P. haydeni* Nels. Bull. Torr. Bot. Club 26: 353, 1899, only in having some of the leaflets orbicular instead of all elliptic to oblanceolate. It is accordingly here given a subordinate rank: *P. haydeni* Nels. **f. orbiculare** (Gand.) W., stat. nov.

oreades Gand. *l. c.* Although characterized in the key as "glabrous," and as having "flowers 4-5 mm. long," well-preserved specimens in American herbaria bearing the type number (Cusick No. 2750) show glandular-pubescent stems and inflorescence-herbage, and corollas 8 mm. long, as in the typical form of *P. californicum* Eastw. Bot. Gaz. 37: 437, 1904. Differing from the latter only in taller stature (30 instead of 15 cm. high) and somewhat less confluent leaflets, it may well become: *P. californicum* Eastw. **f. oreades** (Gand.) W., stat. nov.

oregonense Gand. *l. c.* Another plant considered by Gandoger as "glabrous" but at least in American specimens (of Cusick No. 1717) still more glandular-pubescent than the next-preceding. The corolla-color, given as "white," was according to the collector's printed labels "pale purple." This too differs from the typical form of *P. californicum* Eastw. in only minor respects: basal leaves ½ instead of ¾ the stem-length, and corollas 12 instead of 8 mm. long. It is therefore here reduced to: *P. californicum* Eastw. **f. oregonense** (Gand.) W., stat. nov.

paddoense Gand. *l. c.* Here also our specimens bearing the type number (Suksdorf No. 2766) are pubescent rather than "glabrous" and the leaflets elliptic grading to "obovate subattenuate." This plant is close to the two next-preceding, but has the leaflets rather more confluent, so may become: *P. californicum* Eastw. **f. paddoense** (Gand.) W., stat. nov.

parviflorum Nutt. ex Rydb. Bull. Torr. Bot. Club 28: 29, 1901; a misprint for "parvifolium."

parvifolium Nutt. ex Rydb. Bull. Torr. Bot. Club 24: 253, 1897; first publication of the renaming by Nuttall of his "P. mexicanum." Part of the type material is preserved in the herbarium of the Academy of Natural Sciences of Philadelphia, and differs only in greater compactness from *P. pulcherrimum* Hook. Bot. Mag. 57: pl. 2979, 1830. Brand Pol.: 35, 1907, made it a subspecies of that, and Nelson New Man. Bot. R. Mts.: 404, 1909, used the corresponding simple trinomial. The distinctive features they gave proving to be without significance, it is here reduced to: *P. pulcherrimum* Hook. **f. parvifolium** (Nutt. ex Rydb.) W., stat. nov.

pauciflorum Wats. Proc. Am. Ac. 23: 280, 1888. A well-marked species, characterized by the long tubular-funnelform corolla. For contrasting with two related plants, "P. hinckleyi" Standl. Am. Midl. Nat. 18: 684, 1937, and "P. stenocalyx" Standl. ibid., both regarded as subspecies, the original is here named *P. pauciflorum* Wats. **ssp. typicum** W., nom. nov.

pectinatum Greene Bull. Calif. Ac. Sci. 1: 10, 1884. A clear-cut species, unique in the genus in having narrowly linear leaflets.

pilosum (Greenm.) Jones Univ. Wash. Publ. Biol. 5: 215, 1936. Originally described by Greenman Bot. Gaz. 25: 263, 1898, as "P. viscosum var. pilosum," Gray's interpretation of *P. viscosum* being followed. However, as pointed out by Rydberg Bull. Torr. Bot. Club 24: 252, 1897, and further discussed herein, (p. 755) the plant Gray and Greenman had at hand is not the original *P. viscosum* Nutt. The variant under discussion differing from the typical form of an earlier species only in its more acute leaflets, it may become: *P. shastense* Eastw. **f. pilosum** (Greenm.) W., stat. et comb. nov.

pimpinelloides Willd. ex R. & S. Syst. 4: 793, 1919. A *Phacelia* from Mexico.

pterospermum Nels. & Ckl. Proc. Biol. Soc. Wash. 16: 45, 1903. Tentatively accepted as a valid species, pending further study of seed-characters.

pterospermum (Benth.) Brand Helios 22: 77, 1905. Because this was found to be antedated by the next-preceding, it was withdrawn by Brand Pol.: 33, 1907.

pulchellum Ledeb. Ic. Pl. Fl. Ross. 1: 6 & pl. 20, 1829; authorship accredited to Bunge in Fl. Alt. 1: 233, 1829. A Eurasian plant often assumed to enter North America or to be cultivated here. Establishment of its true status will require field study in northern Asia.

pulchellum coryphocolum Clements ex Brand Pol.: 35, 1907. Classed by Brand as a depauperate form of his "P. pulcherrimum var. delicatum," and here accepted as such in the combination: *P. delicatum* Rydb. **f. coryphocolum** (Clem. ex Brand) W., stat. nov.

pulchellum macranthum Ledeb. Fl. Ross. 3: 85, 1847. =*P. richardsoni* Graham.

pulcherrimum Hook. Bot. Mag. 57: pl. 2979, 1830. This is believed to be the earliest valid name for "P. humile" Willd. ex R. & S. Syst. 4: 792, 1819, which is antedated by "P. humile" Salisb. Prodr.: 125, 1796, holding priority even though illegitimate. The name *pulcherrimum* was expanded by Brand Pol.: 34, 1907, to cover 15 plants which had been considered species by their authors, in many cases apparently rightly so. These plants were arranged, without designating any typical ssp., in a system of 3 ssp., 4 vars., and even one "subvar.," so complex as to be almost impossible to apply to a series of specimens. Correspondingly, the covers in herbaria with the name *pulcherrimum* on the outside usually enclose a highly heterogeneous lot of plants. Here the name is restricted to material bearing more or less resemblance to the figure accompanying the original description. The type locality was along Drummond's crossing of the Canadian Rocky Mountains in British Columbia, but the species ranges from Alaska to northern California and into the Rocky Mountains of Wyoming.

pulcherrimum Hook. ssp. parvifolium (Nutt. ex Rydb.) Brand Pol.: 35, 1907; category undesignated, Nels. New Man. Bot. R. Mts.: 404, 1909. = f. *parvifolium* (Nutt. ex Rydb.) W., p. 751, above. It seems unnecessary to list Brand's other ssp., vars., etc., here.

pumilum Gray ex Rydb. Bull. Torr. Bot. Club 24: 253, 1897. A misreading of a word in Gray's handwriting, which is actually "humile."

quadriflorum Raf. Atl. J. 1(6): 177, 1833. A variant of *P. reptans* L. with the terminal leaflets confluent, not worthy of nomenclatorial recognition.

reptans L. Syst. Nat. (ed. 10): 925, 1759. Previously named *P. caeruleum* γ L. Sp. Pl.: 162, 1753. The new species name was founded on a plate of Miller Figs. Pl. Gard. Dict. 2: pl. 209, 1758; the glabrous plant represented in it came from Virginia, and is accepted as the typical form.

reptans var. macrophyllum Brand Pol.: 33, 1907. A large-leaved variant not here regarded as deserving special naming.

reptans var. villosum Braun Rhodora 42: 50, 1940. Differs from the typical variety (or form) in its herbage being viscid-villous nearly throughout. It is not limited to Ohio and adjacent Kentucky as implied in the original description, but may appear almost anywhere over the range. Its occurrence in Indiana and Illinois was noted by Coulter Cat. Pl. Ind.: 891, 1900, under the designation "the western form;" it is known, however, as far east as Delaware County, in the southeastern corner of Pennsylvania. It may well be reduced to: *P. reptans* L. **f. villosum** (Braun) W., stat. nov.

richardsoni Graham Edinb. N. Phil. J. 4: 175, 1827; fig. in Hook. Bot. Mag. 55: pl. 2800, 1828. Although classed by Brand Pol.: 40, 1907, as equivalent to his "P. lanatum var. humile," it is here maintained as specifically distinct.

robustum Rydb. Bull. Torr. Bot. Club 31: 635, 1904. Made by Brand Pol.: 34, 1907, a subspecies of *P. foliosissimum* Gray, which is here followed. It differs from ssp. *verum* W. only in its larger flowers.

rotatum Eastw. Bot. Gaz. 37: 441, 1904. Accepted as a species, although the corolla does not appear to be any more rotate than that of many others. Much material distributed under this name has the larger leaflets of *P. pulcherrimum* Hook.

rubrum L. Sp. Pl.: 163, 1753. =*Ipomopsis rubra* (L.) W., Bartonia 18: 56, 1936.

scopulinum Greene ex Rydb. Fl. Colo.: 280, 1906. No type specimen having ever been designated for this, record is herewith made that Greene so regarded a sheet in his herbarium collected on Pagosa Peak, Colo., by Baker No. 546, 8/6/'99. This plant was made by Brand an equivalent of "P. pulcherrimum ssp. delicatum" and accepted as the same as his *P. delicatum* by Rydberg Fl. Rocky Mts.: 681, 1917. There is believed to be need, however, for this name in a new status: *P. delicatum* Rydb. **ssp. scopulinum** (Greene ex Rydb.) W., stat. nov. Differs from ssp. *typicum* W. in averaging 50% larger in most of its parts.

shastense Eastw. Bull. Torr. Bot. Club 32: 205, 1905. While originally described from Mt. Shasta alone, this species ranges widely over the Cascade mountain region. The plant mistakenly regarded by Gray Syn. Fl. 2(1): 150, 1878, as *P. viscosum* Nutt. is one of its forms, and "P. viscosum var. pilosum" Greenm. Bot. Gaz. 25: 263, 1898; "P. pilosum" Jones Univ. Wash. Publ. Biol. 5: 215, 1936, another. Brand Pol.: 36, 1907, classed it as "P. pulcherrimum parvifolium berryi subvar. shastense," but it is rather distantly related to any of the first three.

speciosum Fisch. ex Hook. (as synonym) Fl. Bor. Amer. 2: 71, 1838. The same as *P. richardsoni* Graham.

speciosum Rydb. Bull. Torr. Bot. Club 28: 29, 1901. A well-marked species. It was suggested by Brand Pol.: 43, 1907, to be a hybrid of *P. pulcherrimum* and *P. confertum*, but this would require evidence from genetical study to be acceptable. Nelson New Man. Bot. R. Mts.: 405, 1909, placed it in an undesignated category under the very dissimilar "P. mellitum" (Gray) Nels., a procedure which Rydberg Bull. Torr. Bot. Club 40: 478, 1913, well characterized as "evidently erroneous."

stenocalyx Standl. Am. Midl. Nat. 18: 684, 1937. This is too close to the original *P. pauciflorum* Wats. Proc. Am. Ac. 23: 280, 1888, to be maintained as specifically distinct, so is here made: *P. pauciflorum* Wats. **ssp. stenocalyx** (Standl.) W., stat. nov. Differs from ssp. *typicum* W. p. 751, above, merely in having the calyx less pilose and the corolla somewhat shorter. When any considerable series of specimens is examined, however, phases with dense pubescence but short corollas will be found to exist also.

tevisii Eastw. Bot. Gaz. 37: 440, 1904. Made by Brand Pol.: 35, 1907, an equivalent of "P. pulcherrimum parvifolium var. haydeni," and is actually much the same as *P. pulcherrimum* Hook. Bot. Mag. 57: pl. 2979, 1830, though having its leaflets "acute at apex and base" instead of obtusish. (The leaflets were described as confluent on the rachis, but this holds only for the three terminal ones.) There being no other significant differences, it may well become: *P. pulcherrimum* Hook. **f. tevisii** (Eastw.) W., stat. nov. A very similar plant has been named f. *montrosense* (Nels.) W.

tricolor Eastw. Bot. Gaz. 37: 439, 1904. This is accepted as a species because of its few leaflets (rarely over 15) and short styles. The corolla-color is violet with a yellow eye as in many related species, the "reddish purple spots" near the base of the divisions referred to in the description being merely the result of local fading of the violet pigment during drying. Brand Pol.: 35, 1907, reduced it to "P. pulcherrimum ssp. tricolor" but is not here followed.

vanbruntiae Britt. Bull. Torr. Bot. Club 19: 224, 1892 (as "Van-Bruntiae;" simplied by the writer Proc. Pa. Ac. Sci. 9: 151, 1935; Bart 17: 6, 1936.) Guessed by Greene Pitt. 2: 75, 1890, to be identical with a western plant, the name "occidentale" being applied to the complex; he was wrong.

villosum Rud. ex Georgi Beschr. Russ. Reichs (3) 4: 771, 1800. In publishing this epithet, Georgi mentioned only that the plant is tall and has tomentose stems and calyx. He stated it to be fairly common in Siberia and to be represented by a subspecies, for which neither name nor diagnosis were given, "from the Lena to the sea, in northeastern Siberia, also on the islands and the American shores" (*i.e.*, Alaska.) The name "villosum," so far as America is concerned, is thus to be discarded as a nomen nudum. Brand Pol.: 38, 1907, made it "P. caeruleum ssp. villosum" and gave *P. acutiflorum* Willd. ex R. & S. Syst. 4: 792, 1819, as an equivalent, but the latter is here accepted as an independent species.

villosum Sweet Brit. Fl. Gn. 3: pl. 266, 1828. =*P. richardsoni* Graham.

viscosum Nutt. J. Ac. Nat. Sci. Phila. (2) 1: 154, 1848. The original diagnosis of this was fairly complete, including descriptions of the leaflets as ovate or subcordate and scarcely more than a line long, and of the flowers as having a corolla much longer than the elongate lanceolate rather acute calyx-segments. Gray Syn. Fl. 2(1): 150, 1878, proceeded to apply the name "viscosum" to a plant having the corolla "barely twice the length of the calyx" and not having "elongated lanceolate segments of the calyx." Rydberg Bull. Torr. Bot. Club 24: 252, 1897, discussed this confusion and from examination of a Nuttall specimen from the herbarium of the Academy of Natural Sciences of Philadelphia concluded that Gray's procedure was erroneous, and the name *viscosum* should be used for a plant answering Nuttall's original description. He did not explain the reason for Gray's action in the matter; but the sheet in the Gray herbarium gives a clue to this. Above the Nuttall label "Polemonium * viscosum" there is mounted a plant (of *P. shastense* Eastw.) which not only does not fit Nuttall's description of the flowers, but is larger and more complete than Nuttall was accustomed to make his specimens. Evidently an accident occurred in the mounting room, and this specimen and label do not belong together. The Nuttall-Rydberg interpretation of the name *viscosum* is accordingly followed here; the bearing of this procedure on the names "confertum" and "pilosum" has already been discussed above (p. 745 & 752). There remains to be considered the position of Nuttall's plant in the genus. Unfortunately the Nuttall specimen in the herbarium of the Academy of Natural Sciences of Philadelphia, which was presumably intact when Rydberg examined it, has since become fragmented, and only a few scraps remain on the sheet. These are sufficient, however, to show that it belongs in the group with verticillate leaflets, and it is so classified here. It may be known as *P. viscosum* Nutt. **ssp. genuinum** W. nom. nov. The relatively small-flowered plants occurring toward the west side of the species-range may represent a distinct subspecies, but need further field study.

viscosum Nutt. f. *leucanthum* L. Wms. Leafl. W. Bot. 1: 131, 1934. Described as an evanescent albino form; the typical form has deep violet corollas.

viscosum var. pilosum Greenm. Bot. Gaz. 25: 263, 1898. Working at the Gray Herbarium, Greenman naturally followed Gray's interpretation of *P. viscosum*, and associated this supposed variety with it. Here the Gray plant is regarded as one of the forms of *P. shastense* Eastw., and 'pilosum" as another form (p. 752). Brand Pol.: 36, 1907, made the latter "P. pulcherrimum parvifolium var. pilosum" but is not here followed.

The authorship of the accepted species in the above list is as follows:

Adams 1	Graham 1	Lagasca 1	R. & S. 1
Bentham 1	Gray 2	Linnaeus 2	Rydberg 6
Brand 3	Greene 8	Nelson 1	Watson 1
Britton 1	Hooker 1	Nels. & Ckl 1	Wherry 1
Eastwood 7	Jepson 1	Nuttall 1	TOTAL 41

An artificial key is now offered for distinguishing the accepted species and subspecies above listed. For ease of following, one or more words of each characterization are placed in small capitals; and a given introductory expression is not used in more than one pair of lines per page.

Diagnoses are based on the original descriptions, supplemented wherever possible by reference to type material. The members of this genus vary so much that the word "usually" may well be considered as preceding every descriptive term. Sepal-measurements given are those at anthesis; the calyx may increase 50% in size on maturing. Data given in the literature as to extent of sepal-union (often stated in pre-evolutionary terms as depth to which the calyx is cleft) are correspondingly untrustworthy. Leaflet-sizes on vernal leaves are considered most diagnostic.

The corolla-sizes are those shown on herbarium specimens; when using the key with fresh material, allowance should be made for the shrinkage of 30% which often occurs on drying. Corollas are classed as large when their length and/or breadth exceed 18 mm.; medium when 12 to 18 mm.; and small when less than 12 mm. Their most frequent color, often designated blue, is more correctly termed violet; and it is shown by all the species except where otherwise noted. All normally violet-colored species show occasional albino forms; and on drying pale violet corollas may fade to drab, while on the other hand yellowish ones may take on a violet tinge. The term styles is used to include both the compound style and the free stigmatic tips.

KEY TO THE AMERICAN POLEMONIUMS

HABIT strict, the stem erect and simple or terminally branched.

CAULINE LEAVES ± reduced; leaflets mostly free; inflorescence thyrsoid; corolla campanulate with ± rotate limb.

RANGE western; corolla-size medium ..... *P. occidentale;* ssp.:

UPPER LEAVES moderately reduced; plant (25) 50-125 cm. high; inflorescence elongate; B.C.-Calif. & N.M. ..... *typicum.*

UPPER LEAVES markedly reduced; plant 15-25 cm. high; inflorescence subcapitate; Mt. Adams, Wash. ..... *amygdalinum.*

RANGE northern or eastern; corolla-size large.

STAMENS well-exserted; leaflets ovate-lanceolate, rarely over 19 per leaf; W. Va. to N.H. ..... *P. vanbruntiae.*

STAMENS little-exserted; leaflets elliptic-lanceolate.

COROLLA-LOBES orbicular, obtusish, glabrous; leaflets up to 27 per leaf; Eurasia & intr. in e. N.A. ..... *P. caeruleum.*

COROLLA-LOBES ovate, acutish, ± pilose; leaflets rarely over 21 per leaf; Alaska-B.C. & Alb. ..... *P. acutiflorum.*

CAULINE LEAVES little reduced; inflorescence ± corymbose.

LEAFLETS narrowly linear; corolla small; e. Wash. ..... *P. pectinatum.*

LEAFLETS broadly linear or elliptic to ovate, ± confluent.

COROLLA little longer than the calyx; lobes acutish; filaments largely adnate to the tube; Truckee, Calif. ..... *P. helleri.*

COROLLA at least twice as long as the calyx.
COROLLA-SIZE large, the lobes acutish; sepals 10 mm. long; stamens and styles included; s. Colo. - n. Mex. .....*P. grande.*
COROLLA-SIZE medium to small; sepals 6-8 mm. long.
COROLLA-LOBES acuminate, yellow; Ariz. - N. M. .....*P. flavum.*
COROLLA-LOBES not acuminate, forming a ± rotate limb.
LEAFLETS confluent only terminally, on larger leaves 30-50 mm. long; B.C. - Ore. & Ida. .....*P. intermedium.*
LEAFLETS confluent ¼ way down leaf, to 30 mm. long.
INFLORESCENCE compact; corolla-lobes acutish; lower herbage glabrate; se. Ariz. - N.M. .....*P. filicinum.*
INFLORESCENCE ± open-corymbose to subthyrsoid; corolla-lobes obtuse or mucronulate .....*P. foliosissimum;* ssp.:
COROLLA-COLOR white; styles ± exserted.
LEAFLET-WIDTH under 8 mm.; Wyo. - Utah ....*albiflorum.*
LEAFLET-WIDTH over 10 mm.; Ida. - Nev. .....*decurrens.*
COROLLA-COLOR violet (with rare albino forms).
STYLES ± exserted; pubescence sparse to moderate; e. Utah, Colo. & N.M. .....*archibaldae.*
STYLES included; pubescence copious.
FLOWERS rather small: calyx 6-7 and corolla 8-12 mm. long; e. Utah - Colo. .....*verum.*
FLOWERS medium-sized: calyx 7-8 and corolla 12-15 mm. long: Colo. & bordering cos. .....*robustum.*
HABIT spreading, the caudex or stem ± divergent-branched.
LEAVES terete, the leaflets in whorled groups on many or all.
COROLLA-SHAPE campanulate-rotate; sepals ½ united ....(Nevada plant).
COROLLA-SHAPE funnelform-campanulate; sepals over ½ united.
RACEME ± elongate; corolla yellowish, narrow .....*P. brandegeei;* ssp.:
STAMENS decumbent; corolla 20-30 mm. long; Wyo. - Colo. ..... *mellitum.*
STAMENS straight; corolla 30-40 mm. long; Colo. - N.M. ....*typicum.*
RACEME ± short; corolla deep violet, broad.
CAULINE LEAVES with coplanar leaflets to 10 mm. long; corolla 20-25 mm. long; Gray's Peak, Colo. .....*P. grayanum.*
CAULINE LEAVES with verticillate leaflets.
LEAFLET-LENGTH to 15 mm.; calyx to 15 and corolla to 30 mm. long; Wyo. - n. N.M. .....*P. confertum.*
LEAFLET-LENGTH under 6 and corolla under 25 mm. long.
CALYX-LOBES narrow-deltoid, acuminate; calyx 8-12 and corolla 15-25 mm. long; Wash. - Wyo. & Ariz. ..*P. viscosum;* ssp.:
FILAMENTS under ⅔ adnate to tube; range ne. .....*genuinum.*
FILAMENTS over ⅔ adnate to tube; range sw. .....*lemmonii.*
CALYX-LOBES oblong, obtusish; calyx 7 and cor. 13 mm. lg.
STAMENS & STYLES deep-included; Cal. - Nev. ....*P. eximium.*
STAMENS & STYLES exserted; se. Calif. .....*P. chartaceum.*

LEAVES flat, the leaflets paired, coplanar.
CALYX-LENGTH over 12 mm.; corolla large.
COROLLA-SHAPE tubiform; color bronzy-yellow; s. Ariz. & sw. Tex. - n. Mex. ..... *P. pauciflorum;* ssp.:
SEPALS 12-18 mm. long, united 1/3 - 1/2 their length.
COROLLA-LENGTH 30-40 mm.; calyx dense-pilose ..... *typicum.*
COROLLA-LENGTH 25-35 mm.; calyx sparse-pilose ..... *stenocalyx.*
SEPALS 15-20 mm. long, united 1/4 - 1/3 their length; corolla 35 mm. long; pubescence sparse ..... *hinckleyi.*
COROLLA-SHAPE campanulate.
PLANT 25-50 cm. high; calyx-lobes broad, acute; Mex.
HERBAGE dense-villous; corolla violet ..... *P. grandiflorum.*
HERBAGE sparse-villous; corolla yellow ..... *P. luteum.*
PLANT rarely over 20 cm. high; pedicels short; calyx-lobes narrow, acuminate.
PUBESCENCE ± eglandular; leaflets narrow; Mex. ..... *P. ehrenbergii.*
PUBESCENCE ± glandular; leaflets broad; Colo. ..... *P. speciosum.*
CALYX-LENGTH up to 12 mm.; corolla campanulate- rotate.
COROLLA-SIZE large to medium; sepals 8-12 mm. long.
HABITAT, Pacific hills; plant 40-80 cm. high ..... *P. carneum;* ssp.:
LEAFLET-OUTLINE ovate, length to 40 mm., no. to 15; corolla lavender to yellow; s. Wash. to Calif. ..... *genuinum.*
LEAFLET-OUTLINE lanceolate, length to 30 mm., no. to 21; corolla pale to deep violet; w. Wash. ..... *amoenum.*
HABITAT, arctic barrens; plant under 25 cm. high, villous.
CALYX-LOBES broad; leaflets round-ovate; anthers white; styles slightly exserted; Alaska - NW. Terr. ..... *P. richardsoni.*
CALYX-LOBES narrow; leaflets ± elliptic; anthers yellow; styles included; Alaska - Greenl. & Eurasia ..... *P. boreale;* ssp.
LEAFLET-LENGTH up to 10 mm.; wide-ranging ..... *genuinum.*
LEAFLET-LENGTH up to 20 mm.; Bering Sea region ..... *macranthum.*
COROLLA-SIZE medium to small.
COROLLA-TUBE exceeding the 8 mm. long calyx, yellow; herbage dense-glandular; leaflets small; B.C. - Ore. ..... *P. elegans.*
COROLLA-TUBE not exceeding the calyx.
LEAFLET-SIZE large (>20 mm. lg.); calyx-lobes acute.
RANGE eastern; leaflets to 25(50) mm. long ..... *P. reptans.*
RANGE western; herbage ± glandular.
CALYX-SINUSES yellow-callous-based; Mex. ..... *P. mexicanum.*
CALYX-SINUSES green-based; leaflets variable.
CALYX about equalling corolla; n. Calif. ..... *P. calycinum.*
CALYX much <corolla; B.C. - Cal. & Ida. *P. columbianum.*
LEAFLET-SIZE medium-small (<20 mm. lg.)
STYLES decidedly shorter than corolla; leaflets few, half of them decurrent-confluent; n. Calif. ..... *P. tricolor.*

STYLES equalling or exceeding corolla.
MAXIMUM LEAFLET-LENGTH over 7 mm.; leaflets numerous, <1/3 confluent; calyx around 6 mm. long.
LEAFLET-OUTLINE oblong, acute; corolla small; seeds winged; Cloudcroft, N.M. ..... *P. pterospermum.*
LEAFLET-OUTLINE not oblong; seeds wingless.
COROLLA medium-sized; leaflets ± elliptic and free.
BRANCHES ± spreading; rootstock slender and shoots few; Alaska - B.C. ..... *P. lindleyi.*
BRANCHES ± erect; rootstock stout and shoots numerous; B.C. - Wash. & Wyo. ..... *P. haydeni.*
COROLLA small; leaflets in part confluent, variable.
ROOTSTOCK ± erect and stout; lower leaflets petiolulate; styles exs.; Wash. - Calif. ..... *P. californicum.*
ROOTSTOCK ± ascending and slender; lflts. sessile; st. incl.; Ida. - Ariz. & N.M. ..... *P. delicatum;* ssp.:
PLANT to 15 cm. high, leaves to 10 cm. and leaflets to 10 mm. long ..... *typicum.*
PLANT to 20 cm. high, leaves to 15 cm. and leaflets to 20 mm. long ..... *scopulinum.*
MAXIMUM LEAFLET-LENGTH under 7 mm.; calyx small.
RADICAL LEAVES 5-10 cm. long; corolla small.
LEAFLETS obovate, ± confluent; Ore. - Calif. ..... *P. berryi.*
LEAFLETS elliptic to orbicular, mostly free; Alaska - n. Calif. & Wyo. ..... *P. pulcherrimum.*
RADICAL LEAVES under 5 cm. and leaflets 4 mm. long.
STEMS numerous, crowded; leaflets orbicular, sessile; sepals acutish; Klondyke, Yuk. ..... *P. fasciculatum.*
STEMS few; leaflets petiolulate; sepals obtusish.
RANGE, Alaska - n. Wash.; leaflets elliptic; corolla small - medium sized ..... *P. rotatum.*
RANGE, Wash. - Calif.; leaflets ovate to orbicular; corolla small, white or pale ..... *P. shastense.*

Widespread plants	Local dominants	Broad endemics	Narrow endemics
acutiflorum	brandegeei	berryi	calycinum
boreale	californicum	eximium	chartaceum
columbianum	carneum	filicinum	ehrenbergii
delicatum	confertum	flavum	fasciculatum
foliosissimum	elegans	grande	grayanum
haydeni	intermedium	grandiflorum	helleri
occidentale	lindleyi	mexicanum	luteum
pulcherrimum	richardsoni	pauciflorum	pterospermum
reptans	shastense	pectinatum	speciosum
viscosum	vanbruntiae	rotatum	tricolor

In conclusion, a note may be added as to the classification of the species for use in herbaria where the arrangement is systematic. Gray Proc. Am. Ac. 8: 280, 1870, recognized three sections, which were made subgenera and given names by Peter in Engl. & Prantl Pflanzenf. 4(3a): 51, 1897. Here it is held that the third of these, *Polemoniastrum*, deserves independent genus standing, as *Polemoniella* Heller Muhl. 1: 57, 1904. As to the others, Brand Pol.: 30, 1907, did well to return to Gray's view that they are only sections, and to place *Eupolemonium* first and *Melliosma* second. Within them, however, Brand's arrangement was not very satisfactory, in that he often failed to bring out the real interrelationships. The following table shows in a general way the apparent evolutionary relations in the genus.

Systematic Grouping of the American Polemoniums

Coplanar-leaflet group (§ *Eupolemonium*)

Tall subgroup

Ancestral series

1. *intermedium*

Thyrsoid series

2. *occidentale*
3. *vanbruntiae*
4. *caeruleum*
5. *acutiflorum*

Leafy-stem series

6. *grande*
7. *filicinum*
8. *foliosissimum*
9. *helleri*
10. *flavum*
11. *pectinatum*

Dwarf subgroup

Large-flower series

12. *richardsoni*
13. *boreale*
14. *carneum*
15. *speciosum*
16. *grandiflorum*
17. *ehrenbergii*
18. *luteum*
19. *pauciflorum*

Eastern series

20. *reptans*

Medium to Small-flower series

Large-leaflet subs.

21. *columbianum*
22. *calycinum*
23. *mexicanum*

Medium-leaflet ss.

24. *lindleyi*
25. *haydeni*
26. *tricolor*
27. *californicum*
28. *delicatum*
29. *pterospermum*

Small-leaflet subs.

30. *pulcherrimum*
31. *berryi*
32. *fasciculatum*
33. *rotatum*
34. *shastense*
35. *elegans*

Verticillate-leaflet group (§ *Melliosma*)

36. *grayanum*
37. *confertum*
38. *brandegeei*
39. *viscosum*
40. *eximium*
41. *chartaceum*

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Notes on North American Plants—III.

F. R. Fosberg

The third paper of this series contains critical or distributional notes on members of the genera *Bassia* (Chenopodiaceae), *Ribes* (Saxifragaceae), *Opuntia* (Cactaceae), *Pimenta* (Myrtaceae), *Oenothera* (Onagraceae), *Apocynum* (Apocynaceae), *Gilia* (Polemoniaceae), *Richardia* (Rubiaceae), and *Sambucus* (Caprifoliaceae), with new combinations in *Pimenta, Oenothera, Gilia,* and *Sambucus.*

BASSIA HYSSOPIFOLIA (Pallas) O. Ktze.

This rapidly spreading weed, apparently first introduced some years ago in Nevada, may be reported from ½ mile west of Parrish Springs, Minidoka National Forest, Cassia Co., Idaho, McDonald *1360* (USNA, USFS).[1]

RIBES MONTIGENUM McClatchie

The distribution of this species as given in current manuals does not, with the exception of a somewhat problematical reference by Van Dersal (U.S.D.A. Misc. Pub. **303**:236. 1938), definitely include the state of Colorado. The following collections establish its occurrence there. Colorado: Mt. Axtell, alt. 3,000 m. *Tidestrom 4015;* Lake Co., Weston Pass, Cochetopa Forest, alt. 11,200 ft., *Gierisch 1267;* Delta Co., Grand Mesa, alt. 10,000 ft., *Maguire & Piranian 4015,* (all USNA).

OPUNTIA PHAEACANTHA var. MOHAVENSIS (Engelm. & Bigel.) Fosberg

A collection of this rare variety from Lower Deadman Canyon, north end of Sheep Mts., Clark Co., alt. 500 ft., *Train 1786* (USNA) seems to be the first definite record from Nevada, though a plant that I studied, growing in the garden of the late Wright M. Pierce at Claremont, California, may have come either from extreme eastern California or across the line in Nevada. The western Mohave Desert plants which have been referred here belong to *Opuntia phaeacantha* var. *piercei.*

Pimenta racemosa (Mill.) J. W. Moore var. **racemosa,** n. name.

Carophyllus racemosus Mill. Gard. Dict. ed. VIII, no. 5, 1768.
Myrtus acris Sw. Prodr. 79. 1788.
Pimenta acris (Sw.) Kostel. Allg. Med. Fl. **4**:1526. 1835.
Pimenta racemosa (Mill.) J. W. Moore. B. P. Bishop Mus. Bull. **102**:33. 1933.

[1] Herbarium abbreviations used are those recommended in Index Herbarium (Chron. Bot. **5**:142-150, 1939; **6**:377-378, 1941).

This is the typical form of the species which has commonly been designated as *Pimenta acris*, the bay-rum tree. *Myrtus caryophyllata* of Jacquin, Obs. Bot. 2:1, 1767, is simply a misuse of *M. caryophyllata* L., not a new species, and so cannot be transferred. Therefore, *Amomis caryophyllata* Krug & Urban, Engl. Bot. Jahrb. **19**:572, 1895, must either go with Linnaeus' plant or be considered a new name of that date [1895]. *Caryophyllata* therefore can not be the valid specific epithet for the bay-rum tree.

Pimenta racemosa var. **grisea** (Kiaersk.) n. comb.

Pimenta acris var. *grisea* Kiaersk. Bot. Tidskr. **17**:289. 1890.
Amomis caryophyllata var. *grisea* King & Urb. Bot. Jahr. **19**:575. 1895.
Amomis grisea (Kraersk.) Britton. Sci. Surv. Porto Rico and the Virgin Islands **6**:28. 1925.

Moore's resurrection of Miller's specific epithet *racemosa* in place of *acris* for the bay-rum tree of the West Indies necessitates reconsideration of the status of the form of it which has been called *Amomis grisea*.

This form seems to differ only in the noticeable whitish appressed puberulence on all parts, especially the under sides of the leaves, and in the different odor. Moreover, the difference is not a sharp, constant one, as evidenced by the following, quoted from a letter by Mr. Claud L. Horn to Mr. Paul G. Russell dated August 29, 1941.

> I studied these two trees *(Amomis caryophyllata* and *A. grisea)* quite thoroughly in the island of St. John, of the Virgin Islands, and in the forests there, one finds all gradations between the true bay-rum tree and the lemon-scented 'limoncillo.' I cannot whole-heartedly accept without complaint the idea of having two species designations. 'Limoncillo' as I see it, is simply a form of the bay-rum tree.

To my mind, the highest rank that could be assigned to the two is that of varieties of one species.

OENOTHERA HETEROPHYLLA Spach. Nouv. Ann. Mus. Paris 4:348. 1835.

A specimen of *Oenothera* received from Florida raised the question of the distinctness of the plant called by Rose *Raimannia curtissii*. Munz (Am. Jour. Bot. 22:652. 1935) refers this to *Oe. rhombipetala*, a species of the Mississippi Valley. The specimen mentioned above *(McFarlin 12480)*, as well as two isotypes, a cotype, and several other specimens from the same region seem intermediate in several respects between *Oe. heterophylla* and *Oe. rhombipetala*, so much so that they run down more readily in Munz' key to *Oe. heterophylla*. Although they have the narrow leaves and smaller flowers of *Oe. rhombipetala*, the spike is loose and the pubescence of the calyx and hypanthium is spreading and gland-tipped, rather than strigose, though perhaps somewhat strigose also. The aspect of the plant is thus different from either species. Examination of a considerable series of specimens of *Oe. rhombipetala* and a number of *Oe. heterophylla* shows that the rather slight differences between them are not altogether constant. The leaf width of both is variable, as is the flower size and density of the spike. The pubescence of *Oe. rhombipetala* is not always com-

pletely appressed. In a specimen collected at Jamestown, Ohio, by *Wooten* in 1896, the pubescence of the flowers is spreading and glandular and the leaves are quite wide. These facts, with the existence of the intermediate form in the Southeast, lead me to consider these two species as varieties, along with the Southeastern one known as *Raimannia curtissii* Rose. *Oe. heterophylla* Spach is the oldest name applicable to the complex. The three varieties, then, are as follows:

Oe. heterophylla var. **heterophylla,** n. nom.

This is the typical form, with broad leaves, loose spike, large flowers, and spreading, somewhat glandular pubescence or puberulence on the calyx and hypanthium, based on *Oenothera heterophylla* Spach.

Apparently rather rare in Texas and found only there, except for the doubtful *Wooten* specimen from Ohio mentioned above (US).

Oe. heterophylla var. **curtissii** (Rose), n. comb.

Raimannia curtissii Rose. Contr. U. S. Nat. Herb. **8**:330. 1905.
Oenothera curtissii Small. Fl. S. E. U. S. ed. 2. 1353, 1375. 1913.

Leaves narrow, basal ones deeply dentate, spike loose, flowers small, corolla 10-15 mm. long, calyx and hypanthium spreading pubescent, hairs glandular.

Georgia: Bainbridge, *Curtiss 6880* (US, USNA) (type).

Florida: East Pass, *Tracy 6414* (US); Santa Rosa Co., bet. Pensacola and Fort Walton, *McFarlin 12480* (USNA); Appalachicola, *Chapman* in 1884, cult. from plants obtained at Bainbridge, Georgia (US).

Oe. heterophylla var. **rhombipetala** (Nutt.), n. comb.

Oe. rhombipetala Nutt. ex T. & G. Fl. N. Am. **1**:493. 1840.
Raimannia rhombipetala (Nutt.) Rose. Contr. U. S. Nat. Herb. **8**:331. 1905.

Leaves narrow, spikes dense, flowers small, pubesecnce strigose.

Mississippi Valley south to Texas, east to Indinana, introduced sparingly further east.

APOCYNUM CANNABINUM L.

A reexamination of the plant called by me *Apocynum sibiricum* var. *salignum* in my paper on the Aestival Flora of the Mesilla Valley, New Mexico, shows that it is merely *A. cannabinum*. There is no excuse for the error in determination.

GILIA (NAVARRETIA) BREWERI Gray. (*Navarretia breweri* (Gray) Greene)

This species, one of the most easily recognized and widespread of subgenus *Navarretia*, has been known from California, Oregon, Washington (acc. Rydberg), Nevada, Utah, Wyoming, and Colorado. I have seen no reference to it from Idaho. It may be reported on the basis of *Gierisch 664* (USFS), from Minidoka Forest, Twin Falls Co., Idaho.

Gilia aggregata var. **arizonica** (Greene), n. comb.

Callisteris arizonica Greene, Leaflets **1**:160. 1905.
Gilia aggregata subsp. *eu-aggregata* var. *typica* subvar. *arizonica* Brand, Pflanzenr. IV, 250: 115. 1907.
Gilia arizonica (Greene) Rydb. Bull. Torr. Cl. **40**:472. 1913.

This plant differs only slightly from the variable *G. (Ipomopsis) aggregata* (Pursh) Spreng. found further north and west. It differs constantly in the position of the anthers, about two-thirds the way up the corolla tube, as opposed to the exserted anthers of *G. aggregata* var. *typica* Brand. *G. aggregata* var. *attenuata* Gray has the anthers at the top of the corolla tube or barely included. Var. *arizonica* is also usually set apart by a floccose tomentum in the lower parts, but this is by no means constant.

Utah: Washington Co., Dixie Nat. Forest. *Plummer 120* (USNA, USFS); *Plummer 55* (USFS). Pinto Can. *Raphael & McAllister 93* (USFS). Iron Co. near Newcastle, Marsh 13770 (USNA).

Arizona: Wupalki Nat. Monument. *Purchase 542* (USNA).

Nevada: Clark Co.: Wheeler Spring, 19 mi. e. of Pahrump. *Train 2049* (USNA); Deer Creek, 6 mi. n.e. of Mt. Charleston, *La Rivers & Hancock 485* (USNA); Deer Creek Rd., Lookout Point, 3 mi. s. Lee Can., *Train 2131* (USNA); Sheep Mt., 30 mi. w. of Moapa, *Train 1919* (USNA); Willow Creek, 3 mi. n. of Cold Spring, n. end of Charleston Mts. *Train 2006* (USNA); Hidden Can., Sheep Mt., *La Rivers & Hancock 601* (USNA); Sheep Mts., Desert Game Range, Clark or Lincoln Co., *Jewett 47* (USNA).

RICHARDIA HUMISTRATA (Cham. & Schl.) Steud. nom. ed. II, 2:459. 1841.

Richardsonia humistrata Cham. & Schl. Linnaea **3**:353. 1828.

This species may be reported as a weed or waif new to North America. Specimens collected Sept. 9 and Sept. 12, 1941, by *E. G. Hume,* (USNA) from sod land along R.R. at Cantonment near Pensacola, Florida, match very well material in the U. S. National Herbarium of the above species from Uruguay. It is apparently rare in South America, as only two sheets are in the National Herbarium.

The plant is a prostrate herb, white hirsute and with ovate acuminate leaves, narrowed to a short petiole-like base. The specimens are fruiting, bearing dense involucrate heads of loosely held obovate nutlets borne in 4's, a few heads still have dried, 4-parted flowers. The corollas are small and inconspicuous. This species is aberrant in this genus in being tetramerous, as most of the species are trimerous.

The three[2] species now known from the United States may be separated as follows:

1. Flowers and fruits 4 parted, the fruit separating into 4 almost smooth obovate nutlets, the scar broad, not or scarcely excavate. (Florida, Uruguay, Brazil, Peru) ..... *R. humistrata*

1. Flowers and fruits 3 parted, fruit muriculate.

2 I regard *Richardia tricocca* (T. & G.) Standl. as a member of the genus Diodia, in spite of the tricoccous fruits.

2. Nutlets obovate, scar broad, open, excavate (known from Texas and from Florida to Virginia in U. S., pantropic).....*R. brasiliensis* (Moq.) Gomez.
2. Nutlets nearly cylindric, scar closed to a narrow groove (Texas to Florida and north to Virginia, pantropic) .....*R. scabra* L.

I know of no good way to distinguish specimens of *R. scabra* from those of *R. brasiliensis* in the absence of mature fruit.[3] Both are apparently widespread weeds in warm countries, but much that has passed as *R. scabra* is really *R. brasiliensis*.

Sambucus racemosa var. **arborescens** (T. & G.), n. comb.

S. pubens var. *arborescens* T. & G. Fl. N. Am. **2**: 13. 1841.
S. callicarpa Greene, Fl. Fran. 342. 1892.
S. racemosa var. *callicarpa* Jepson. Man. Fl. Pl. Calif. 965. 1925.

Jepson is apparently correct in assigning only varietal status to Greene's *Sambucus callicarpa*, as it differs mainly in the thickness of the leaf, and the fact that the leaves exceed the flower clusters and other habital characters. However, the earliest varietal epithet to be applied to this plant of the northwest coast of America was that of Torrey and Gray, taken from a manuscript name by Nuttall.

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3 See Fernald, M. L. Rhodora **43**:645. 1941.

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A Raised Cattail-Tule Bog in Yellowstone National Park

George B. Rigg

A raised cattail-tule bog has developed between a flat sagebrush desert and the base of a steep hill whose dry soil supports only a very sparse vegetation. It is east of Yellowstone Lake at Mary Bay and is plainly visible from the highway that extends from Fishing Bridge toward Sylvan Pass. The green color of the bog vegetation in summer contrasts sharply with the gray of the sagebrush desert lying in front of it and also with the lack of distinct color on the hill beyond it. The bog extends somewhat irregularly (Fig. 2) a distance of about 350 feet along the base of the hill and extends outward from the hill to a width of about 120 to 165 feet. There is a strip of level mineral soil a few feet wide between the bog and the base of the hill. The adjacent portion of the bog surface is at about the same level as this strip of soil. A considerable portion of the bog is only slightly convex and the bog slopes down somewhat irregularly from this level to the sagebrush desert (Fig. 1). The elevation of the highest portion of the surface of the bog above the flat desert is estimated to be about 8 or 10 feet. The bog is thus not distinctlty either dome-shaped or ridge-shaped, but is rather built against the base of the hill and raised above the flat desert (Fig. 2).

The purpose of this paper is to describe the plant associations now occu-

Fig. 1. General view of sagebrush desert, bog and hill. The margin of the highway along Mary Bay is seen in the foreground with the weedy roadside vegetation bordering it. The barren spot in the barrier at the front of the bog is seen in the center of the picture. The barrenness of the upper portion of the hill and the desert-like character of the vegetation of its lower portion are clearly seen.

pying the bog and to record some data bearing on the factors that have probably operated in the development of the bog. Four plant associations constitute the vegetation cover of the bog at the present time. The cat-tail association and the tule association give the aspect to the bog as seen in summer from the highway or from the flat desert, and cover by far the larger portion of its surface. Two others, however, a grass association and a cow-parsnip association, occupy portions of it. The cat-tail *(Typha latifolia)* covers the central portion extending from the base of the hill almost to the side bordering the desert. The tule *(Scirpus occidentalis)* covers two smaller areas, one at each end of the bog. The grass *(Phalaris arundinacea)* covers a small portion on the side toward the desert, and at a somewhat lower level than the portion occupied by the cat-tail and the tule. The cow-parsnip *(Heracleum lanatum)* occupies a small portion not far from the grassy area and at about the same level.

Although these four dominant species mingle a good deal, especially at the borders, each association is quite distinct as seen from the upper slope of the hill above. All four species are perennials. Since each is dominant in its own area and there is no distinct evidence of consistent encroachment of any of them on the others, each seems to be climax in its own area. It seems probable that differences in abundance of water constitute a large factor in determining the areas occupied by these four associations. The highest portion of the bog, occupied by the cat-tail and the tule, is very wet and water an inch or two in depth stands on the surface in many places. The areas occupied by the grass and the cow-parsnip, though at a somewhat lower level, had less water at the surface at the time of the visits of the writer (Sept. 1934, June 1937, Aug. 1941).

Fig. 2. General view of the bog looking northwest along the base of the hill from the top of the next hill south of the one that is directly back of the bog. A portion of Mary Bay, Yellowstone Lake is seen at the upper left and a small lake at its right. The sagebrush desert is seen immediately beyond the bog. The fact that the tule area in the foreground is not uniformly daminated by the tule is clearly shown as is also the irregularity of the border of the bog next to the hill.

A number of other species are found in the bog with these four dominant ones. These are a five-finger *(Potentilla gracilis)*, water parsnip *(Sium cicutaefolium)*, two sedges *(Carex rostrata* and *C. Geyeri)*, arrow grass *(Triglochin maritima)*, a dock *(Rumex occidentalis)*, a monkey flower *(Mimulus guttatus)*, an aster *(Aster fluviatile)*, a thistle *(Cirsium foliosum)*, a larkspur *(Delphinium glaucescens)*, a bedstraw *(Galium aparine)*, a bluebell *(Mertensia ciliata)*, a rue *(Thalictrum occidentale)*, a monkshood *(Aconitum columbianum)*, and a willow herb *(Epilobium adenocaulon)*. The species listed above are characteristic of wet places and are not confined to any one of the four associations. The following points on distribution were, however, noted. Among the plants common in the cat-tail association are *Phalaris, Heracleum, Aster, Epilobium, Potentilla,* and *Carex*. Considerable *Triglochin* and some Aster are found in the cow-parsnip association. The grass association contains some *Heracleum*. The tule association in general contains relatively few species other than the dominant.

Other species more characteristic of the drier places bordering the bog are two geraniums *(Geranium viscosissimum* and *G. Richardsonii)*, two goldenrods *(Solidago missouriensis* and *S. canadensis)*, a paintbrush (*Castilleja* sp.), a composite *(Helianthella uniflora)*, a flax *(Linum Lewisii)*, an owl-clover *(Orthocarpus luteus)*, a gentian *(Gentiana plebeia)* a stick-seed (*Lappula* sp), yampa *(Carum Gairdneri)*, yarrow *(Achillaea millefolium)* and a species of sagebrush *(Artemisia aromatica)*. The dominant in the sagebrush desert is *Artemisia tridentata*.

Borings were made at five points in the bog with a Davis peat borer to determine the depth and character of the soft material and the nature of the mineral substratum on which the bog rests. Clay (mostly blue), with some gravel was found at four points at depth varying from 5 to 10 feet. At the fifth point gravel with some blue clay on the surface of the particles was found at 8 feet. The deepest place found (10 feet) is in the center of the bog in the cat-tail association. The next in depth (8 feet) is in the edge of the tule association where it borders the cat-tails north of the center. In the parsnip area the depth was 8½ feet; in the cat-tail area close to the hill, 7 feet; in the east portion of the tule area toward the sagebrush, 5 feet. The microscopic characters of the blue clay indicate that it is not of glacial origin.

These data are not sufficient to give a complete picture of the form of the bottom of the bog, but indicate that it is probably a least somewhat basin like. The maximum thickness of the blue clay bored was 8 inches, but the borer did not go through the layer in any case, so the thickness of the layer of clay and gravel is undetermined. It was impossible to force the borer deep into it. This is the usual experience in boring into blue clay at the bottom of bogs. This material underlies many sphagnum bogs throughout northern United States (Rigg 1940) and it seems to function in preventing water from percolating into the material underlying this cattail-tule bog just as it does in spagnum bogs. The rhizomes and roots of the cat-tail and the tule form a

thin mat at the surface of the bog. Under this, and extending down to the clay and gravel is grayish granular material consisting largely of diatoms and clay with much water and occasionally some plant remains. There is very little peat in this bog.

A ridge of solid material borders each end of the bog and also at least a considerable portion of the front. An undrained basin with a rather impermeable bottom is thus formed on the flat at the base of the hill and this is the usual condition for holding water and causing the formation of a bog. The front of this hill is approximately in line with the fronts of several other hills bordering the flat nearby. It seems evident that they are the remains of what was once a cliff which has now been cut into by streams, thus forming separate hills. It seems probable that the barriers forming the ends of this basin consist of material brought down by these streams. A glance at Fig. 1 will indicate the probability of this. A small creek still trickles, even in late summer, just south of the barrier at the south end of the bog, just to the right side of Fig. 1. The surface of Yellowstone Lake in Pleistocene times was at one time 160 feet and at another time 60 feet above its present level (7731 feet). These higher levels were due to an ice barrier. To what extent phenomena occurring while the lake was at these higher levels or during the melting of the ice barrier and the recession of the lake to its present level may have operated in the formation of this basin is not known.

A portion of the barrier at the front of the bog is at present largely barren of vegetation (center of Fig. 1) and is composed of hard material consisting of silica with much sand and some small animal fossils. A small stream of water (76° F.) with algae growing in it trickles from this ridge in one place and a pool of warm water (72° F.) stands in the bog not far from it. It seems evident that the portion of the barrier that can now be seen has been deposited from warm springs. To what extent such a ridge may underlie the remainder of the front of the bog has not been determined.

The surface of the bog is very wet, and water an inch or two in depth stands on even the highest portion. Since the hillside back of the bog is very dry and supports only a sparse vegetation, and the sagebrush desert in front of it is likewise very dry, it seems evident that the water comes from a subterranean source with very little pressure behind it. It can scarcely be called artesian water since it does not exhibit sufficient pressure. It is better characterized as a spring. Since this water is not perceptibly warm (56° F.) its origin can scarcely be connected with the warm springs which have formed the barrier at the front. It seems probable that the water that is responsible for the growth of the vegetation on the bog at the present time enters at the east side of the bog near the base of the hill. Two lines of evidence support this view. (1) The surface of the bog near the hill is generally higher and is almost flat, and slopes more, though irregularly, toward the side away from the hill. (2) The tule, in a few places, especially toward the south end, extends irregularly up the hill a few feet. It thus seems that the factors operating in the development of this bog are (1) the entrance of subterranean water on the side next to the hill, (2) the existence of a relatively impermeable layer

of material at the bottom and (3) the existence of a barrier at each end and at least a partial barrier at the front.

Raised bogs that have some points of structure and development in common with Yellowstone bog are known to occur in Ohio and Utah. Gordon (1933) has described a dome-like raised bog due to artesian water at Urbana, Ohio. Its center is about 11 feet above the surrounding land. Its surface is a mat of vegetation about one foot thick, whose most characteristic plant is shrubby cinquefoil *(Potentilla (Dasiphora) fruticosa)*. This mat is "supported by hydrostatic pressure." Under it is water 12 feet deep. An iron pipe has been driven into the center of this bog with its upper end a foot above the surface of the bog. Clear cold water flows from this pipe. In 1935 Dr. E. N. Transeau guided the writer to several (about 20) small dome-like raised bogs in a level pasture near Huntsville, Ohio. The surface of the largest of these bogs has an elevation of about 6 feet and has a mat of peat, muck and vegetation about 2 feet thick. Under this is water about 4 feet deep. The other Huntsville bogs are similar to this one in structure. Shrubby cinquefoil is the most abundant species on the older ones and a species of *Carex* is most characteristic of the younger ones. All of these bogs have originated within the memory of a man still living in 1935. They are due to artesian water whose source has been traced. They have developed over openings through a clay hard pan overlying limestone and underlying a peat-muck soil. Water seeps from even the highest portions of their surface. These bogs are relatively impermanent, rising for a period of years and then falling, with the development of new mounds elsewhere.

In 1936 Dr. W. P. Cottam and Dr. S. Flowers guided the writer and Dr. L. D. Phifer to several raised bogs of irregular form in the dry region near Provo, Utah. Cottam (1926) has described these bogs fully and has discussed their origin. The following notes are from excerpts from his thesis which he has kindly furnished to the writer. They are small isolated bogs surrounding natural artesian springs which have broken through a layer of impervious hard pan six inches to one foot in thickness. This water becomes permanently ponded and the ponds are soon surrounded by a vigorous growth of sedges and grasses which steadily encroaches until the open water is completely invaded. The dense covering of vegetation characteristic of the mature bogs is a sedge-Helenium association, and there are probably no plants peculiar to the bogs alone. The artesian springs still pour out clear cold water which trickles down the sides of the bogs in deep narrow trenches. Some of the older bogs have peat deposits exceeding ten feet in thickness at the maximum depth and are several feet higher than the surrounding land. The peat as shown by samples at depths from one to 8 feet is more or less uniform in color and texture, and is composed principally of organic remains of marsh plants. It has a hydrogen ion concentration lying between pH 7.1 and 7.2. Temperatures taken May 30, 1926 are: bog spring 12.9°C., peat at depth of 4 inches 19.2° C., peat at depth of 3 feet 14.8° C.

The essential difference between the Huntsville bogs and the Utah bogs seems to be that in the former the peat-muck layer is raised from a flat posi-

tion to a dome form by pressure of the artesian water from beneath with some subsequent changes in the flora, while the later originate by the growth of vegetation around and upon ponds formed by artesian water and the peat accumulates from the remains of these plants.

Raised bogs such as Yellowstone bog and the Ohio and Utah bogs differ in origin, structure and flora from raised sphagnum bogs. The latter have layers of peat from top to bottom, while the former have only a mat at the surface with mostly water underneath. The latter are formed by the accumulation of material from the continued upward growth of plants (mainly *Sphagnum*), the water used being taken from the surface of the mineral substratum while the former are either formed on water or are raised by its pressure. No upward pressure of water is evident in the latter, while there is always more or less upward pressure of the water in the former. Sphagnum bogs have a characteristic flora, largely selected by the physical and chemical conditions brought about by the living *Sphagnum* and the peat consisting of its remains (Rigg 1940), while the Yellowstone bog and the Ohio and Utah bogs have a general flora of swamp plants. Sphagnum bogs are often spoken of as "acid" bogs since sphagnum causes the water in which it grows to have an acid reaction (Rigg 1940), while other plants do not. In distinction from "acid" bogs those bogs that do not have sphagnum are frequently called "alkaline" bogs. The acidity referred to is, of course, due to acids other than carbonic acid which may be formed in water by the respiration of any aquatic plants.

The writer wishes to thank Dr. C. Max Bauer, Head Naturalist of Yellowstone National Park, for permission to do the work on this bog and for generous encouragement and assistance during the progress of the work. He wishes also to thank Ranger Naturalists Dr. Arthur Nash and Dr. E. T. Bodenberg for assistance and valuable suggestions during the field work. It would be impossible to list all of the Ranger Naturalists whose courtesies were so very helpful during the three different years that the writer worked on this bog. Grateful acknowledgement is also made to Dr. C. L. Hitchcock and Dr. Lincoln Constance for the identification of plants, to Professor G. E. Godspeed for the identification of mineral materials, and to Mr. Richard Foster for photographs and assistance in field work.

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Bibliographical Miscellany—IV.

A Bibliogeographical Guide to the Brandegee Botanical Collections

Joseph Ewan

The Brandegees were alert botanical explorers both. First botanical collector to reach the "Four-corner's country" of southwestern Colorado, Townshend Stith Brandegee contributed importantly by his collections before that exploration to the first flora for the state, that of Prof. Thomas C. Porter and John M. Coulter of 1874. Prior to 1874 Brandegee collected about Canyon City, in the "Sierra Majado"[1], and as far north as Breckenridge. With Hayden's exploring expedition of southwestern Colorado (1875) Brandegee sought out the novelties of the San Juan, Rio Mancos, and Rio la Plata drainages. During these exciting days of the 1870's he was the contemporary of several naturalists who were then penetrating the wholly unknown "wastes" of southern Utah and remote parts of the Great Basin. Across the Utah borders Lester F. Ward botanized the Aquarius Plateau to at least 8700 feet, Rabbit Valley, and the Dirty-Devil River with Powell's Survey. Within the Rocky Mountains of Colorado Dr. W. A. Bell visited the Purgatory River, H. N. Patterson, the foothills of the Gore Range, and Marcus E. Jones botanized on Argentine Pass and elsewhere. J. H. Redfield collected on Grays Peak, Greene on the mountains above Golden City, F. V. Hayden in North Park, John M. Coulter on White Horse Mountain and about California Gulch, also on Mt. Elbert, while Porter carefully collected about Chiann Canyon and Pikes Peak.

For a young man just out of Sheffield Scientific School of Yale, trained in surveying, acquainted with botany through his father and uncle who were interested amateurs, finding himself divided between topographic engineering and botanical exploration—for all this Brandegee threw himself into his western adventures with enthusiasm. Soon Brandegee becomes the botanist. For it was during this period, the second period which Setchell has recognized in his life (1926, 161), that Brandegee determined to abandon engineering in favor of botany. This decision must have been encouraged by the warm praise from Asa Gray upon the excellence of his collections, and very possibly as well to a purported fact referred to by Marcus E. Jones in his brief biography of the Brandegees (cf. Contrib. West. Bot. 18:15. 1933). I refer to Brandegee's receipt of a legacy of forty thousand dollars at about this time; surely the amount was intelligently invested in a botanical library of unusual completeness. But all these events preceded his explorations of Baja California. Adding together the distances travelled on the several trips, Brandegee says of these: "I have ridden the whole length of the peninsula on a mule." His collections in Lower California were well prepared, carefully labelled (at least in the prime set), and were written upon first by Brandegee himself and later by other students of the peninsular flora. T. S. Brandegee's collections within Alta California were, in the aggregate, somewhat less intensive than those of his wife but his explorations of the Snow Mountain region of Lake County, Sequoia National Park area of Tulare County, and of the inner South Coast Ranges of western Fresno County, were each of a highly pioneering sort.

Before Mary Katharine (Layne) Curran's marriage to T. S. Brandegee in 1889 she had begun collecting plants about Alta California, surely at first stimulated by the energies and enthusiasm of Edward Lee Greene who had discovered the fascination of California's flora, following a residence in New Mexico and Colorado. She likely met Greene at the meetings of the California Academy of Sciences at San Francisco sometime between 1878 and 1882. Though neither Katharine Brandegee in her auto-

1 Sierra Majado has not been located on any of several maps examined!

biographical sketch (cf. Setchell, 1926, 167) nor her two biographers Setchell or Jones mention this early influence of Greene, it is, nevertheless, important, for without his stimulating encouragement, precisely such as the sending of her collections from the high country of the Yosemite and elsewhere to Asa Gray and other eastern systematists, Katharine Brandegee might never have been fired to pursue further exploration. It was at about this time that Greene himself described many of the collections of Katharine Brandegee, then Mary K. Curran, as new species to botanical science (cf. original descriptions of *Astragalus Layneae*, *Mimulus Layneae*, and others). Her subsequent criticisms of the botanical work of Greene in the periodical Zoe and elsewhere are well known. Of this Setchell writes: "her reviews of [Greene's] work were searching and her criticism of his attitude of mind caustic. Hers was at times a bitter pen, but in reality she held little personal antagonism for any length of time". Perhaps this was, in general, true but her particular vitriolic criticisms of Greene were surely in part the aftermath of unrequited love.

Katharine Brandegee became interested in recollecting at then already classic botanical localities in California. Thus in 1914 she visited Northfork, Madera County, in the southern Sierra Nevada, where Mrs. Peckinpah had detected the narrow endemic *Collomia rawsoniana*, the species bearing her commemorative maiden name bestowed by Greene. In 1909 she visited the ranch of the R. A. Plasketts in southern Monterey County. Culbertson botanized in the Sierra Nevada of Tulare County in July, 1904; Mrs. Brandegee followed him there, collecting at his precise stations, in July 1905. Some of these trips were manifestly to recollect topotype material of little known plant species or to obtain additional material of a presumed "novelty" communicated to the Academy by an inquiring correspondent or currently published by one of the residents of California. However, some of these efforts toward recollection followed an obsession of Katharine Brandegee to seek out intermediates for proposed new species and depose them and their proponents in the columns of Zoe. From Jones's worshipful biography I take a revealing sentence: "[Hers] was a judicial face, and all conversation was the weighing of the evidence of the validity of species of plants."

Though all of this collecting activity of the Brandegees lead to the formation of one of the richest private herbaria ever assembled in this country, both collectors were most casual, with Katharine Brandegee even pernicious, in the matter of recording data upon their plant labels. No field notebooks appear to have been kept by either of the Brandegees, and, apart from a short series taken by him in Fremont County, Colorado, no collections appear to have been numbered. The Baja California collections are perhaps the best labelled.

CRITICAL NOTES AND CORRECTIONS

Carl F. Baker distributed sets of the San Diegan collections of the Brandegees, made in 1903, and these, in common with Baker's usual practice, bear numbers given them by Baker, not by Brandegee. As indicated above certain T. S. Brandegee collections made in Colorado about 1873 carry numbers; these were distributed with printed labels and are captioned "Hayden's Survey of Colorado Territory." Another practice of about that time was indicated to the author at the Academy of Natural Sciences of Philadelphia, where the Porter Herbarium is now housed. This was the use of a printed Brandegee label with the data penned in by Prof. Porter; these labels, very likely supplied by Porter, likewise bear collection numbers. I have seen other collections carrying labels supplied by J. H. Redfield, one-time curator of the Philadelphia Academy's herbarium. Similarly Canby distributed the Brandegee collections made on the Northern Transcontinental Survey under numbers given not by Brandegee but by himself. There has been apparently some mixture of this Washington state material. Thus Rollins (State Coll. Wash. Research Stud. 4:22. 1936) cited the instance of *Arabis Koehleri*, a species credited to Washington solely upon the basis of Brandegee's collections. Furthermore, Rollins (litt. of 17 II 1938) informs the author of *Arabis Bolanderi* being attributed to Washington upon Brandegee's specimens when otherwise known only from northern California. *Thelypodium Howellii* of southern and eastern Oregon is again reported from Washington exclusively upon

the basis of Brandegee's collection. It need hardly be added that such citations as "Brandegee 13293", occasionally seen in monographs, do not refer to a number given by the collector but to one given subsequently.

Widespread error in year dates has been noticed in Katharine Brandegee's collections. Some of these are indicated in the accompanying list of collections arranged by year. Carelessness in the use of the appropriate form label has resulted in a few instances of confusion. Some errors have proved especially hazardous. For example, through a "7" having been written instead of a "9" the type collection label of Eastwoodia elegans carries a yeardate twenty years prior to T. S. Brandegee's actual visit to Alcalde, western Fresno County, California.

Duplication of place names in California eventuates in confusion among species of a characteristic and limited distribution. A few examples of these errors may be cited: Although there is a San Felipe Creek in Baja California, the locality of that name of T. S. Brandegee is rather to the one along the western borders of the Colorado Desert of San Diego County, California. Though Katharine Brandegee was shipwrecked at San Pedro, Los Angeles coast, in 1893, she did not collect plants there so far as I have verified. The "San Pedro" of her labels, without any additional data, refers to the station of that name seventeen miles south of San Francisco in San Mateo County. This is established by her collection of *Veronica americana* which does not occur at the southern California locality but does occur at the San Mateo County station. "Mt. Eden" of K. Brandegee's labels refers to a sea level flagstation on the shores of San Francisco Bay, precisely west of San Leandro, Alameda County, and not to a mountain summit! Again, "San Gregorio" of T. S. Brandegee refers to the locality of Baja California, located precisely in the account herewith; "San Gregorio" of Katharine Brandegee, to the seacoast town north of Santa Cruz. T. S. Brandegee *never* collected plants at the San Mateo County "San Gregorio"; Katharine Brandegee, at "San Gregorio," Baja California! Yet there is no guiding phrase generally on the labels of either collector. T. S. Brandegee collected during the same year, 1910, at Toll House, above Calistoga, Napa County, and at Toll House, Fresno County, California.

One of the most interesting instances of mistaken identities for Brandegee collecting localities involves the type locality of a Californian *Sphaeralcea* and a *Chorizanthe*. Katharine Brandegee visited and botanized at two distinct "Indian Valleys." In the days when Asa Gray addressed her as "Mrs. Layne-Curran" she visited Indian Valley, Monterey County, of the South Coast Ranges, interesting for its singular floristic aspect, combining as it does several rather unlike floristic sources. Twenty-five years later, 1910, she collected in Indian Valley, Lake County, of the North Coast Ranges. It was only by matching dates and working out itineraries that the type locality of *Sphaeralcea aboriginum*, named by B. L. Robinson for its original place of collection, was correctly determined to be the Monterey County place of that name. This was given in W. L. Jepson's *Flora of California* (vol. 2, p. 499. 1936).

EXPLANATORY NOTES

There are two arrangements of data herewith, viz. a chronologic array of collecting localities for T. S. and Katharine Brandegee in turn, which aims to give as nearly as possible a connected itinerary. This is followed by a gazetteer of place names for each collector, facilitating the placing of a lone place name appearing on an herbarium label. The county of any particular place name may be determined easily by reference to these gazetteers. In the organization of the place names as taken from labels toward a connected itinerary the dates have been followed carefully, or when no date has been found for a place name it has been inserted in the connected itinerary according to geographic dictates. The bibliography of the writings of the Brandegees supplied by Setchell (1926) will be found helpful in determining puzzling names which may have been omitted from the present account. Though the present account has been assembled over a period of years it is necessary to admit that some place names still have not been located or fitted into the Brandegee itineraries.

HYPOTHETICAL LIST OF LOCALITIES

Localities for which I lack sufficient information to place them in the accompanying account, either due to want of yeardate, or county for the place name, may be enumerated as follows:

Alabama Cave, county? yeardate?
Brighton, Sacramento Co., yeardate?
Chorro, San Luis Obispo Co., yeardate?
Gold Run, Placer Co., yeardate?
Grand Island, Sacramento Co., probably 1893?
La Honda, San Mateo Co., yeardate?
Leesville, Colusa Co., yeardate?
Mission Cliff, San Diego Co., yeardate?
Mormon Island, county? yeardate?
Mountain House (Colusa or Alameda Co.?), yeardate?
New Idria, San Benito Co., yeardate?
Natetno River, Wash., county? (spelling uncertain), 1882.
Nicasio, Marin Co., yeardate?
Ockenden, Fresno Co., yeardate?
Rancheria, county? yeardate? (spelled with capital R)
Rodeo Lagoon, (Marin or Contra Costa Co.?), 1905
Santa Maria Mts., e. Mohave Desert, yeardate?
Searsville, San Mateo Co., yeardate?
Sherman Island, Sacramento Co.?, probably 1893?

ACKNOWLEDGEMENTS

The present account was begun during my residence at the University of California, 1933-37, and is naturally based in a large part upon the Brandegee Herbarium permanently placed there. To the actual records in the herbarium have been added citations gleaned from botanical literature, especially monographs of limited scope. A very considerable number of entries have been added from the author's personal visits to the Dudley Herbarium, and the Rocky Mountain, Field Museum, Missouri Botanical Garden, Philadelphia Academy of Natural Sciences, and California Academy of Sciences herbaria. Troublesome place names of the Brandegees have been noted by Dr. W. L. Jepson and his kindness in placing these facts at my disposal is gratefully acknowledged. Mary Bonsall Parish and Lois Chambers Taylor of Berkeley have given assistance in various matters, and my wife, Nesta Dunn Ewan, has revised the lists and abstracted citations to the betterment of the account.

ITINERARY OF TOWNSHEND STITH BRANDEGEE

Born at Berlin, Conn., 16 Feb. 1843; died at Berkeley, Calif., 17 April 1925.

1869 Berlin, Conn., 1 VIII. **1871** Canyon City, Colo., 5343 ft., Fremont Co., n.d.; Breckenridge, 9700 ft., Summit Co., n.d.[2] **1872** Canyon City, n.d., Wet Mt. Valley, Fremont Co. (present Custer Co.), VII. **1873** Canyon City, 23 VII, 8 VIII; Grand Canyon of Arkansas [River], n.d.; Wet Mt. Valley (present Custer Co.), n.d.; Wild Cat Park, Fremont Co., n.d.[3] **1874** Canyon City, n.d.; Greenhorn Mts., n.d.; bed of D. & R. G. RR.[4] at Pueblo, VII; Sangre de Cristo (also written "Sangre de Xto" on labels), Saguache Co., VIII.; Thompsons Park, 7500 ft., n.d.; Texas Creek, 8000 ft. (present Fremont Co.), n.d. **1875** Soda Spring Ledge, Canyon City, 5400 ft., n.d.; Saint Charles Plains, n.d.; Huerfano Plains, n.d.; Mosca Pass,[5] early VI; Del Norte on Rio Grande, VI; Wagonwheel Gap, VI; crest of "Sierra Madre," VI; Los Pinos Creek, n.d.; Piedra Mts., n.d.; Rio la Plata, La Plata Co., VI; Mesa Verde, VII; San Juan R., VII; betw. Mt. Elmo and Montezuma creeks, San Juan R., VII; McElmo Valley, 5500 ft., VII; El Late Mts., 9840 ft., VIII; Cariso Mts., ca. 9000 ft., ne. Arizona, n.d.; valley of Rio Animas, 6500 ft., n.d.; bluff near Hovenweep Castle, 5250 ft., VIII; San Juan R.[6] near

2 "n.d." here and elsewhere signifies no date or date wanting.
3 Wild Cat Park has not been located on any map.
4 That is, Denver & Rio Grande (Western) Railroad.
5 A trail 1850, a road 1870-1910, again a trail, over crest of Sangre de Cristos.
6 Valley of San Juan R. fide T.S.B. means a "district north of the river about twenty miles wide."

Utah state line, VIII; Recapture Creek,[7] VIII; Tums Ranch, Rio Mancos, IX; head of Rio Grande, Mineral Co., IX; Los Pinos trail, banks of Rio Grande, New Mexico, n.d.; San Luis Valley, IX. **1876** Above Frank's Ranch, 6500 ft., Fremont Co.,[8] X. **1877** Canyon City, V; Sierra Majado, 5900-6500 ft., VI; Mill Creek, 7 mi. s. Canyon City, 7 VI; Pancho [i.e. Puncho] Creek, 9000 ft., Lake Co., VIII; Chrysolite Mt.[9] and Mt. Antero, Saguache Range, n.d.; Crestones, Sangre de Cristo Range, IX. **1879** (Stationed at La Junta, Colo., and Santa Fe, N.M.) Martenitas Canyon, n.d. and La Glorieta, n.d., both San Miguel Co., New Mexico. **1880** "Sawtooth Range" [probably variant of Saguache, or as it appears on some labels, "Sawatch Range," as T. S. B. was locating route of the Denver and South Park RR. at elevations of 7000 to 11000 feet in this region during 1880], n.d.; Las Lagunitas near Las Vegas, San Miguel Co., N.M., n.d. **1881** Elk Mts., n.d. [As a member of engineer corp T. S. B. was supervising the location of railway from Gunnison City up Ohio Creek during 1881]. **1882** Yakima region, Wash., n.d.; Walla Walla region, Wallawalla Co., Wash., V; Natetno River,[10] n.d.; the Dalles, Ore., n.d.; Cascade Mts., n.d. (with Frank Tweedy). **1883** Walla Walla region, Wash., VI (the second year with Northern Transcontinental Survey under William Canby as botanical collector and surveyor); Ellensburg, Kittitas Co., Wash., IX; Yakima region, Wash., IX. **1884** Bartlett Mt., Lake Co., Calif., V-VI; Kelseyville, VI; Antioch, Contra Costa Co., VI. **1885** Oregon City, Klackamas Co., Ore., V; Portland, Ore., V; Cloverdale, Sonoma Co., Calif., VII; Santa Lucia Mts., Monterey Co., VIII (In search of *Abies venusta* as botanical collector for Jesup Wood Collection of Am. Mus. of Nat. Hist.); San Simeon, VIII; Jolon, n.d.; Cottonwood Canyon, Fish Creek, Nev., VIII; San Francisco, 10 IX; Happy Camp trail, Siskiyou Mts., Del Norte Co., IX (for *Picea breweriana* for Jesup Wood Collection); Waldo, Josephine Co., Ore., IX; Grants Pass, Ore., IX.[11] **1886** Amador Co., Calif., IV, V; Wileys (i.e. Wylies sta.), 25 V; Reno, Nev., VII; Jolon, Monterey Co., n.d. (Still with appointment as collector for Jesup Wood Collection). **1887** Sissons, Mt. Shasta, VII; Hornbrook near Klamath R., Siskiyou Co., Calif., VII (again in search of *Picea breweriana*); Coles, VII; Ager, VII. **1888** Santa Cruz Isl., IV (in search of logs! of *Lyonothamnus* and *Quercus tomentella*, though a careful collection of herbs of the island was also made); Tamalpais, Marin Co., V; Paper Mill Creek, V12; Alpine, n.d.; Antioch, Contra Costa Co., V; Santa Rosa Isl., VI ("I made a complete collection of the plants of the island"—T.S.B.); Kelsey, Lake Co., 26 VI; Mt. Hanna, n.d.; Pt. Sur, Monterey Co., VII; Howell Mt., Lake Co., VIII; Donner Lake, Placer Co., IX; Verdi, Nev., IX; Reno, IX. (Lakeside, San Diego Co., n.d. cannot be fitted into this year's trips). **1889** (Married the former Mary Katharine Layne Curran at San Diego on 29 May) Magdalena Isl., L.C., 13 I; San Gregorio, 2 II; Santa Margarita Isl., 2 III; San Regnis (possibly a misreading of label, not given by Grinnell, 1926), 3 III; Comundu, 22 III; San Ignacio, 17 IV; San Luis, 18 IV; San Julio, 20 IV; El Paso Alemon, 24 IV; Calmalli, 24-25 IV; El Rancho Viejo, 29-30 IV; Ubi, 8-9 V; Los Huevitas, 20 V; San Quentin, 22 V. (At this point begins the wedding trip, on foot, from San Diego to San Francisco, botanizing along the way) San Diego, "south side Los Angeles Co.", Santa Catalina Isl., Ravenna, V, Tehachapi, V (this may be a mistake though colls. made by both T.S.B. and K.B. at this locality in May are extant; if correct, they must have retraced their route to Saugus and passed thru Santa Clara Valley toward the coast for their next collecting locality is:) Santa Barbara, V, mountains back of Santa Barbara, San

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7 Here an attempted theft of mules by Indians was thwarted, hence Recapture Creek, fide T. S. B. in Setchell, 1926, 157.

8 Not located on maps.

9 Cf. Setchell, 1926, 157.

10 Place name hardly legible on label; not located on maps of Washington.

11 "Mt. Stewart," properly Mt. Stuart, Wash., mentioned by T. S. B. in Setchell, 1926, 159, must belong here but no colls. seen from that locality.

12 H. N. Bolander collected here (type loc. of *Circaea pacifica!*) in 1860's.

Marcos, Santa Inez, San Simeon, VI, Monterey, VI (reached via pass from San Simeon to Jolon, San Antonio Mission, Milpitas Creek, Tassajara and Carmel R. drainage), Big Trees of Santa Cruz, 16 VI (i.e. Felton); Ben Lomond, Santa Cruz Co., 17 VII, Redwood City, San Francisco. A short trip was made together, as follows: Alta, Placer Co., 6 VII; Donner, 8 VII. Though I find no corresponding dates for K. B., it is likely that the following trip was made together: Sissons, Mt. Shasta, VII; Hornbrook, Siskiyou Co., VII. The following collecting localities cannot be placed in this itinerary, perhaps some are outright mistakes in yeardates, as elsewhere suggested in this paper: Pixley, V; Healdsburg, VII; Avery, Calaveras Co., 6 VII; Mt. Diablo, n.d. **1890** Todos Santos, L.C., 28 I; Caliente, Kern Co., Calif., IV; Olancha, Inyo Co., IV; Libertys, e. flank Mt. Tamalpais, 2 V; Mission Hills, San Francisco, V; Santa Catalina Isl., 12-14 V; Monterey, VI; Calaveras Big Trees, 3 VII; Sheep Rch., on road (returning from) Calaveras Grove, 7 VII; San Jose del Cabo, L.C., 3-19 IX; Sierra de San Francisquito, L.C., 18 X; San Jose del Cabo, 2 XI; La Paz, 5 XI. **1891** Goshen, nw. Tulare Co., Calif., 285 ft., 2 IV; Keller, Inyo Co., 14 IV; Inyo, 15 IV; Cottonwood Rch. on Cottonwood R., Inyo Co., 17 IV; Caliente, Kern Co., 11 V; Kernville, 2600 ft., 13-14 V; Havilah, 15 V; Walker Basin, 16 V; Alcalde, Fresno Co., 852 ft., V; Coburn Mill, 29-30 V; Springville, Tulare Co., 30-31 V; Porterville, 31 V; Tamalpais, Marin Co., 12-14 VI; Bolinas Heights, 14 VI; Snow Mt., Lake Co., 22-24 VI; Murphys, Calaveras Co., 2, 7 VII; Calaveras Big Trees, 4 VII; Arthur, 6 VII; Santa Rita Mts., Arizona, 1 XI. (San Jose del Cabo, L.C., 30 IV cannot be placed). **1892** Inyo, Inyo Co., 15 IV; Hermosillo, Sonora, Mexico, 14 V; Nogales, Ariz., 24 V; Kernville, Kern Co., 14 V; Hot Springs, 15 V; Walker Basin, 16 V; Huron, Kern Co., V; Mt. Tamalpais, Marin Co., 13 VI; Honey Lake, Lassen Co., 22-25 VI; Milford, Lassen Co., 26 VI; Janesville, Lassen Co., 30 VI; Susanville, Lassen Co., 30 VI-2 VII; Prattsville, Plumas Co., 3 VII-9 VII; Sequoia Mills, Tulare Co., 19-22 VII (with K.B.); General Grant Grove, 20 VII (with K.B.); Milwood, 23 VII; Badger, 24 VII; Canyon of Kaweah R., 26 VII (with K.B.); Mineral King, 27 VII (with K.B.); Visalia, 31 VII; San Joaquin R. bridge near Lathrop, San Joaquin Co., 9 IX; Red Bluff, Tehama Co., 20 IX. **1893** Tulare Lake, Tulare Co., 24 III; Zapato Chino Creek, 25-29 III; Alcalde Fresno Co., 30 III; Cariso Creek "Rocks," just below Tiajuana, L.C., 19-21 IV; Sauzal, L.C., 24 IV; San Antonio near Ensenada, 3-4 IV; Salado Canyon, 27 IV; San Pedro Martir, V (Charlotte May Wilder, who with her husband, accompanied Anthony brothers, T. S. B. and was cook for party, tells me that they ascended to 8000 feet to a point where they could see across to Old Mexico beyond the Gulf. They walked from Tiajuana to the mts. and return. Incidental to her cooking Mrs. Wilder made up mammal skins, 200 in all, which were sold to the Am. Mus. Nat. Hist. at a dollar a piece. This defrayed the cost of the trip.—Ewan mss. dated 25 V 1937); Vallederos Creek, 29 V (on return from mts.); Aliso, 30 V; San Telmo, 31 V; San Antonio, 3-4 VI; Snow Mt., Lake Co., 23 VI; San Jose del Cabo, L.C., IX (inserted under 1893 upon the statement of K.B. (cf. Setchell, 1926, 167) though I have seen no colls. of either Brandegee from the Cape region for this year; to be sure there is record of such in Erythea 5:6-7). (Mazatlan, 8 X of T.S.B. may belong to this Cape trip though I have no other record to accompany it). (For a narrative of the San Pedro Martir trip by A. W. Anthony, with several additional place names given, see Zoe 4:228-247. 1893.) **1894** Foster, San Diego Co., 2 IV; Romona, 3 IV (with K.B.); betw. Rancho San Vincente and Lakeside, 3 IV; Palm Creek, 18 IV; San Felipe Creek, 27 IV; Borregos Springs, on edge Colorado Desert, 28 IV (unless wrong form label used a record for K.B. indicates they made this trip together); San Felipe, about 2400 ft., 29 IV; Warners Rch., 30 IV; Julian, 12-15 VI; El Vulcan (i.e. Volcan Mt.), 16 VI; Laguna Mts., 20 VI; Cuyamaca to 6000 ft. on Cuyamaca Peak, 6-11 VII; San Clemente Isl., 25 VIII; Stonewall, San Diego, Co., 15 X; Nuevo (or San Vincente Nuevo), 16-17 X. (Several dates for San Diego. It was in 1894 that they moved to San Diego from San Francisco, living "high on the mesa above town, with a brick building to house their herbarium and a small but well-stocked botanical garden"—W.A.S. Random colls. were also made

this year at Encinitas and Del Mar and several about Romona.). **1895** Point Loma, San Diego Co., 23 III; San Diego, 1 IV; Julian, 15 IV; San Felipe, 16 IV; Masons, La Puerte Valley; Borregos Sprs., 17 IV; Palm Creek, 18 IV; Grapevine Spr., 22 IV; Borregos Springs, 22 IV; Mesa Grade, 22 IV. Cuyamaca Mts., VI. **1896** Masons, La Puerte Valley, San Diego Co., 9 IV; Vallecitos, 10 IV (this and next with K.B.); Agua Caliente (now Palm Springs), 10 IV; San Felipe, 13 IV; "Colorado Desert foothills" (i.e. vic. San Felipe, e. San Diego Co.), 13 IV; Cuyamaca Mts., 3 VI; Romona, 29 VI; Falls of San Diego R., 7 VII. **1897** Todos Santos Isl., L.C., 9 III; Guadalupe Isl., 10 III; San Martin Isl., 13 III; San Geronimo Isl., 15 III; San Benito Isl., 27-28 III; Cedros Isl., 1 IV, 7 IV; mainland near "Ascension Isl." (properly Asuncion Isl.), 4 IV; Natividad Isl., 10 IV; San Roque, n.d.; Asuncion Isl., 17 IV; Teton Forest Reserve, Wyo., VII-VIII (preparation of a forest map of the reserve). **1898** Palomar, n. San Diego Co., 1 VIII. **1899** Magdalena Isl., 13 I; San Felipe, e. San Diego Co., V (with K.B.); Cape San Jose del Cabo to Cape region mts., 20 IX; Sierra de la Laguna, 2 X; San Jose del Cabo, 16 X. **1901** Julian, San Diego Co., 24 III; Vallecitos, 26 III; Carisso Creek, 27 III; Indian Wells, 28 III; Cameron Lake, 28 III; Signal Mt., Imperial Co., 30 III; San Felipe Creek and Gap, 6-7 IV; Ironwood Sprs., 7 IV; Iron Springs Mt., 7 IV (all with K. B.). Doubtful is: San Joaquin Bridge, San Joaquin Co., 9 IX. **1902** University Heights, San Diego Co., 10 V; Providence Mts., e. San Bernardino Co., 25 V-6 VI (one of more important explorations of T.S.B.); Warrens Rch., n. end Morongo Valley, 15 V; Warrens Well, 16 V; betw. Twenty-nine Palms and Bagdad, 20 V; Bagdad near Amboy, 21 V; Danby, 22 V; Mission Valley, San Diego Co., VI; San Jose del Cabo, L.C., 25 XI; Pescadero, XI. Doubtful is: Janesville, Lassen Co., 28 VI (probably wrong yeardate on label). **1903** Several dates for San Diego (It is to be remembered that colls. were made for C. F. Baker's exsiccatae during this year); Romona, 10 VII. **1904** Descanso, San Diego Co., 2 VI; Tighes Rch. (later Geo. Stone Rch.), 15 VI ("first stage station between Romona and Julian at the foot of the Ballena grade"—K. B. in Univ. Calif. Herb. Record [for 1907] ms.); Dulzura, 16 VI; Campo, 17 VI; El Cajon, 20 VI; Laguna Mts., 20 VI; Culiacan, Sinaloa, Mexico, 30 VIII; Altata, vic. Culiacan, 2 IX; vic. Culiacan, 10 X. (It may be this trip when he stopped at the base of Cerro Colorado in Sinaloa, referred to by T. S. B. in Setchell, 1926, 159). **1905** Warners Rch., San Diego Co., IV; Ironwood Well (i.e. Yaqui Well fide Jepson, Fl. Calif. 2:85), IV; Coyote Wells, IV; Cottonwood Creek, IV; Split Mt., IV; Mountain Springs Grade to Colorado Desert, IV; Jacumba, IV; "Wilder's" (i.e. Charlotte May Wilder's ranch in the Jarupa Hills, Riverside Co.), 18 V. **1906** Lakeside, San Diego Co., n.d.; Ramona, III; Tallys, betw. Julian and Cuyamaca, V (this and succeeding localities with K. B. though not so indicated on labels); "High mountain" near Descanso (probably one of the high ridges behind the town of Descanso, unlikely Cuyamaca Peak), 24 V; Descanso, 24 V. **1909** Warrens Well, s. Mohave Desert, San Bernardino Co., 16 V. **1910** Cuyamaca Mts., VI (with K. B.). **1913** Silver Canyon, Inyo Co., VII (with K. B.).

GAZETTEER FOR COLLECTIONS OF T. S. BRANDEGEE

(County designation follows the first comma; yeardate (s), the second comma)

(All place names are in California unless otherwise stated)

Ager, Siskiyou, 1887
Agua Caliente, Riverside, 1896
Alcalde, Fresno, 1891, 1893
Aliso, Mexico (Baja Calif.), 1893
Alpine, Marin, 1888
Alta, Placer, 1889
Altata, Mexico (state of Sinaloa), 1897, 1904
Amador County (without loc.), 1886
Antioch, Contra Costa, 1884, 1888, 1889
Arthur, Calaveras, 1891
"Ascension" or properly Asuncion Isl., Mexico (Baja Calif.), 1897
Avery, Calaveras, 1889

Badger, Tulare, 1892
Bagdad, San Bernardino, 1902
Bartlett Mt., Lake, 1884

Berlin, Conn., 1869
Bolinas Heights, Marin, 1891
Borego Springs, San Diego, 1894, 1895
Breckenridge, Summit Co., Colo., 1871

Calaveras Big Tree Grove, Calaveras, 1890, 1891
Caliente, Kern, 1890, 1891
Calmalli, Mexico (Baja Calif.), 1889
Cameron Lake, Imperial, 1901
Camp Badger, see Badger
Campo, San Diego, 1904
Canyon City, Fremont Co., Colo., 1871-74, 1877
Cape region mts., Mexico (Baja Calif.), 1899
Cariso Creek, Mexico (Baja Calif.), 1893
Cariso Creek, Imperial, 1901
Cariso Mts., ne. Ariz., 1875
Cascade Mts., Wash., 1882
Cedros (or Cerros) Isl., Mexico (Baja Calif.), 1897
Chrysolite Mt., Mt. Antero, Chaffee Co., Colo., 1877
Cloverdale, Sonoma, 1885
Coburn Mill, Tulare, 1891
Coles, Siskiyou, 1887
Colorado Desert foothills (i.e. near San Felipe, San Diego), 1896
Comundu, Mexico (Baja Calif.), 1889
Cottonwood Canyon, Fish Creek, ?Washoe Co., Nev., 1885
Cottonwood Creek, San Diego, 1905
Cottonwood River (or Ranch), Inyo, 1891
Coyote Wells, Colorado Desert, 1905
Crestones, Saguache Co., Colo., 1877
Culiacan, Mexico (state of Sinaloa), 1904
Cuyamaca Mts., San Diego, 1895-96, 1910
Cuyamaca Peak, San Diego, 1894
Cuyamaca, San Diego, 1894

Dalles, Wasco Co., Ore., 1882
Danby, San Bernardino, 1902
Del Mar, San Diego, 1894
Denver & Rio Grande RR. bed, Pueblo Co., Colo., 1874
Del Norte, Rio Grande headwaters., Colo., 1875
Descanso, San Diego, 1904, 1906
Donner, Placer, 1889
Donner Lake, Placer, 1888
Dulzura, San Diego, 1904

El Cajon, San Diego, 1904
Elk Mts., Gunnison Co., Colo., 1881
El Late (i.e. Sierra el Late, Montezuma Co.), Colo., 1875
Ellensburg, Kittitas Co., Wash., 1883
El Paso Alemon, Mexico (Baja Calif.), 1889
El Rancho Viejo, Mexico (Baja Calif.), 1889
El Vulcan, San Diego, 1894
Encinitas, San Diego, 1894

Fish Creek, ?Washoe Co., Nev., 1885
Foster, San Diego, 1894
Franks Ranch, Fremont Co., Colo., 1876

General Grant Grove, Tulare, 1892
Goshen, Tulare, 1891
Grand Canyon [of the Arkansas R.], Colo., 1873
Grants Pass, Josephine Co., Ore., 1885
Grapevine Spring, San Diego, 1895
Great Canyon of the Arkansas (error for Grand Canyon), Colo., 1873
Greenhorn Mts., Pueblo-Huerfano county line, Colo., 1874
Guadalupe Isl., Mexico (Baja Calif.), 1897

Happy Camp trail, Del Norte, 1885
Havilah, Kern, 1891
Healdsburg, Sonoma, 1889
Hermosillo, Mexico (state of Sonora), 1892
High Mountain near Descanso, San Diego, 1906
Honey Lake, Lassen, 1892
Hornbrook, Siskiyou, 1887, 1889
Hot Springs, Kern, 1892
Hovenweep Castle, Montezuma Co., Colo., 1875
Howell Mt., Napa, 1888
Huerfano plains, Colo., 1875
Huron, Kern, 1892

Indian Wells, Imperial, 1901
Inyo, Inyo, 1891, 1892
Ione, Amador, 1889
Iron Springs Mt., Colorado Desert, 1901
Ironwood Spring, ?San Diego, 1901
Ironwood Well (Yaqui Well), San Diego, 1905

Jacumba, San Diego, 1905
Janesville, Lassen, 1892
Jolon, Monterey, 1885, 1886
Julian, San Diego, 1894, 1895, 1901
Jurupa Hills, Riverside, 1905
Keeler, Inyo, 1890, 1891

Kelsey, Lake, 1888
Kelseyville, Lake, 1884, 1885
Kernville, Kern, 1891

La Glorieta, San Miguel Co., N. M., 1879
Laguna Mts., San Diego, 1894, 1904
La Paz on Gulf of California, Mexico (Baja Calif.), 1890
Las Lagunitas, San Miguel Co., N. M., 1880
Lakeside, San Diego, 1888, 1906
Libertys, Marin, 1890
Los Angeles county, 1889
Los Huevitas, Mexico (Baja Calif.), 1889
Los Pinos trail, N. M., 1875

McElmo Valley, Colo., 1875
Magdalena Isl., Mexico (Baja Calif.), 1889, 1899
Martenitas Canyon, San Miguel Co., N. M., 1879
Masons, San Diego, 1895, 1896
Mazatlan, Mexico (state of Jalisco), 1893
Mesa Grande, San Diego, 1895
Mesa Verde, Montezuma Co., Colo., 1875
Milford, Lassen, 1892
Mill Creek, Fremont Co., Colo., 1877
Millwood, Fresno, 1892
Mineral King, Tulare, 1892
Mission Hills, San Francisco, 1890
Mission Valley, San Diego, 1902
Monterey, Monterey, 1890
Montezuma Creek, Colo., 1875
Mosca Pass, Custer Co., Colo., 1875
Mt. Antero, Chaffee Co., Colo., 1877
Mt. Diablo, Contra Costa, 1889
Mt. Hanna, Lake, 1888
Mt. Stewart (Stuart), Kittitas-Chelan Co., Wash., 1885
Mt. Tamalpais, Marin, 1892
Mountain Springs Grade, San Diego, 1905
Murphys, Calaveras, 1891

Natetno R., Wash., 1882
Natividad, Mexico (Baja Calif.), 1897
Nogales, Santa Cruz Co., Ariz., 1892
Nuevo, San Diego, 1894

Olanche, Inyo, 1890
Oregon City, Klackamas Co., Ore., 1885

Palm Creek, San Diego, 1894, 1895
Palm Springs (formerly Agua Caliente), Riverside (formerly San Diego), 1896
Palomar, San Diego, 1898
Pancho Creek, Lake Co., 1877
Papermill Creek, Marin, 1888
Parrott City, La Plata Co., Colo., 1875
Pescadero, Mexico (Baja Calif.), 1902
Piedra Mts., Colo., 1875
Pixley, Tulare, 1889
Point Loma, San Diego, 1895
Point Sur, Monterey, 1888
Porterville, Tulare, 1891
Portland, Ore., 1885
Prattsville, Plumas, 1892
Providence Mts., San Bernardino, 1902

Ramona, San Diego, 1894, 1896, 1903, 1906
Recapture Creek, Montezuma Co., Colo., 1875
Red Bluff, Tehama, 1892
Reno, Washoe Co., Nev., 1886, 1888
Rio Grande, Mineral Co., Colo., 1875
Rio la Plata, La Plata Co., Colo., 1875
Romona (see Ramona)

Saint Charles Plains, Huerfano Co., Colo., 1875
Salado Canyon, Mexico (Baja Calif.), 1893
San Antonio near Ensenada, Mexico (Baja Calif.), 1893
San Benito Isl., Mexico (Baja Calif.), 1897
San Clemente Isl., San Diego, 1894
San Diego, San Diego, 1889, 1894, 1895, 1902, 1903
San Diego River, San Diego, 1896
San Felipe, Mexico (Baja Calif.), 1893
San Felipe, San Diego, 1894, 1895, 1899, 1901
San Francisco, San Francisco, 1885, 1891, 1893
San Geronimo Isl., Mexico (Baja Calif.), 1897
Sangre de Cristo Range, Saguache Co., Colo., 1874
San Gregorio, Mexico (Baja Calif.), 1889
San Ignacio, Mexico (Baja Calif.), 1889
San Joaquin River, San Joaquin, 1892, 1901
San Jose del Cabo, Mexico (Baja Calif.), 1890, 1891, 1899, 1902
San Juan River, Montezuma Co., Colo., 1875
San Julio, Mexico (Baja Calif.), 1889
San Luis, Mexico (Baja Calif.), 1889
San Luis Valley, Alamosa Co., Colo., 1875
Santa Margarita Isl., Mexico (Baja Calif.), 1889
San Martin Isl., Mexico (Baja Calif.), 1897
San Miguel Co., N. M., 1879
San Pedro Martir, Mexico (Baja Calif.), 1893

San Quentin, Mexico (Baja Calif.), 1889
San Regnis (?), Mexico (Baja Calif.), 1889
San Simeon, Monterey, 1885
Santa Catalina Isl., Los Angeles, 1889, 1890
Santa Cruz Isl., Santa Barbara, 1888
Santa Lucia Mts., Monterey, 1885
Santa Rita Mts., Ariz., 1891
Santa Rosa Isl., Santa Barbara, 1888
San Telmo, Mexico (Baja Calif.), 1893
San Vincente Rancho, San Diego, 1894
San Vincente Nuevo (see Nuevo)
Sausal del Comanche (see Sauzal)
Sauzal, near Ensenada, Mexico (Baja Calif.), 1893
Sawtooth Range (error for Saguache Range), Colo., 1880
Sequoia Mills, Tulare, 1892
Sheep Ranch, Calaveras, 1890
Sierra de la Laguna, Mexico (Baja Calif.), 1899
Sierra de San Francisquito (part of Sierra de la Laguna), Mexico (Baja Calif.), 1890
Sierra Madre, Mineral Co., Colo., 1875
Sierra Majado, Fremont Co.?, Colo., 1877
Signal Mt., Imperial, 1901
Silver Canyon, Inyo, 1913
Sinaloa, Mexico, 1904
Siskiyou Mts., Siskiyou, 1885
Sissons, Siskiyou, 1887, 1889
Snow Mt., Lake, 1891, 1892, 1893
Soda Spring Ledge, Fremont Co., Colo., 1875
Split Mt., Colorado Desert, 1905
Springville, Tulare, 1891
Stonewall, San Diego, 1894
Susanville, Lassen, 1892

Tamalpais, Marin, 1888, 1890, 1891
Tehachapi, Kern, 1889
Teton Forest Reservation, Wyo., 1897
Texas Creek, Fremont Co., Colo., 1875
Thompsons Park, Colo., 1875
Tighes Ranch, San Diego, 1904
Todos Santos, Mexico (Baja Calif.), 1890
Todos Santos Isl. off Ensenada, Mexico (Baja Calif.), 1897
Toll House, Mt. St. Helena, Napa, 1889
Tulare Lake, Tulare, 1893
Tums Ranch, Montezuma Co., Colo., ants), Mexico (Baja Calif.), 1889
Twenty-nine Palms, San Bernardino, 1902

Ubi (see Grinnell, 1928, 32, for vari-
University Heights, San Diego, 1902 1875

Vallecitos, San Diego, 1896, 1901
Vallederos, Mexico (Baja Calif.), 1893 (or Valladares, Sierra San Pedro Martir)
Vallederos Creek, Mexico (Baja Calif.), 1893
Verdi, Washoe Co., Nev., 1888
Valley of Animas River, Colo., 1875
Visalia, Tulare, 1892

Wagonwheel Gap, Mineral Co., Colo., 1875
Waldo, Josephine Co., Ore., 1885
Walker Basin, Kern, 1891, 1892
Walla Walla region, Wallawalla Co., Wash., 1882, 1883
Warners Ranch, San Diego, 1894, 1905
Warrens Ranch (or simply "Warrens"), San Bernardino, 1902
Warrens Well, San Bernardino, 1909
Wet Mountain Valley, Fremont Co., Colo., 1872, 1873
Wild Cat Park, Fremont Co., Colo., 1874
Wilders Ranch, Riverside, 1905
Wileys (or Wylies), Amador, 1886
Wyoming, 1897

Yakima region, Yakima Co., Wash., 1882, 1883
Yaqui Well, San Diego, 1905
Yubay (see Ubi)

Zapato Chino, Tulare, 1894
Zapato Chino Creek, Tulare, 1893

ITINERARY OF MARY KATHARINE (LAYNE) (CURRAN) BRANDEGEE

Born in western Tenn., 28 Oct. 1844[13]; died at Berkeley, Calif., 3 April, 1920

1882 (Though Katharine Brandegee says that she began collecting in 1882 I have seen no sheets bearing that yeardate; if collected they seem not to be represented in

13 Birthplace here given is that stated by Setchell, 1926, 167, on the basis of Katharine Brandegee's own memorandum. M. E. Jones gives Carson City, Nev., as her birthplace, however, though it seems natural to accept her own declaration for an unnamed place in western Tenn. (cf. Jones, 1935, 12.).

the Brandegee Herbarium today. Of course much early material placed in the California Academy of Sciences at this time were subsequently destroyed in the San Francisco fire). **1883** (Accepted curatorship of botany at Calif. Acad. Sci. this year, serving 1883 until 1893) Antioch, Contra Costa Co., n.d.; Judsonville, V; Mt. Diablo, n.d.; Folsom, Sacramento Co., V; Newcastle, n.d.; Yosemite Valley, Mariposa Co., VI; Clouds Rest above Yosemite Valley, 9000 ft., VI; Grizzly Canyon, Lake Co., VI; Summit (being the "summit" of the Central Pacific RR. pass across the Sierras), Placer Co., VII; Donner Lake, VIII; Sweetwater Creek, Eldorado Co., VIII. (South Dome, Yosemite, belongs in this sequence but monthdates are conflicting). **1884** Sweetwater, Eldorado Co., IV; Roseville, Placer Co., IV; Folsom, Sacramento Co., VII; Strongs Canyon near Truckee, n.d.; Reno, Nev., n.d.; Geiger Grade near Steamboat, Nev., n.d.; Bear Valley, Colusa Co., V; Antioch, Contra Costa Co., V-VI; Allens Springs, Lake Co., VI; Lakeport, VI; Cobb Mt., VI; Boggs Lake, n.d.; Bottle Glass Mt., n.d.; Coldstream, VII; Hough Springs, VII; Bartlett Mt., n.d.; Kelsey Mt., n.d.; swampy ground at Eppersons on Williams-Bartlett Springs road, VII; entrance to Andersons Springs, 14 VIII; doubtful are the following: Bakersfield, Kern Co., VII and Keene sat., VI. Lancaster sta., Los Angeles Co., labelled VII probably carries wrong monthdate. Amboy, and Yucca, both on S. F. RR., Mohave Desert, probably belong here. **1885** Judsonville near Antioch, Contra Costa Co., V; Placer Co., V; Geiger Grade near Steamboat, Nev., VI; Slack Canyon, s. Monterey Co., VI; Indian Valley near Salinas R., VI; on mts. near San Luis Obispo, VII; Los Alamos, Santa Barbara Co., VII; (Gaviota, without yeardate probably belongs here); on seashore near Santa Barbara, VII; "along roadside for several miles," San Buenaventura (i.e. present Ventura), VII; San Luis Rey, San Diego Co., VII. **1886** Carbondale, Amador Co., V; Ione, n.d.; Volcano, 23 V; Antioch, Contra Costa Co., V; Valley Ford, Lake Co., 5 VI; Allen Sprs., VI; Kelseys, VI. **1887** Valley Ford, Lake Co., VI; Sissons, Mt. Shasta, VII; Edgewood, VII; Mt. Shasta, VII (probably Mt. Shasta City, since there is at hand no record of an ascent of the mt. nor is she particularly mentioned in this connection by Cooke, Am. Midl. Nat., 1940); Ager, Willow Creek of Klamath drainage, VII (with T.S.B.). **1888** Near Santa Barbara, betw. Hatchs wharf and Monticello, n.d.; San Simeon, San Luis Obispo Co., n.d.; Pt. Sur, Monterey Co., VII; Laguinitas, Marin Co., VII; Mt. Hannah, Lake Co., VII (with T.S.B.); Howell Mt., VIII; Blue Canyon, Placer Co., IX; Truckee, IX; Summit, IX; Donner Lake, IX; Donner Park, Nevada Co., IX; Reno, Nev., IX; Angel Isl., San Francisco Bay, X. **1889** (Married Townshend Stith Brandegee at San Diego, 29 May). Ione, Amador Co., IV; Tracy, IV; Mt. St. Helena, V; Lakeport, V; Howell Mt., Lake Co., n.d.; Colusa Jct., Colusa Co., n.d. Doubtful is: Masons, La Puerte Valley, e. San Diego Co., IV; Tehachapi, Kern Co., V. (The wedding journey from San Diego to San Francisco has been presented under the itinerary of T.S.B.). **1890** Above Mill Valley, Mt. Tamalpais, Marin Co., 13 IV; Libertys, IV; Mt. Eden, Alameda Co., 27 IV; Ben Lomond, Santa Cruz Co., 28 IV; San Gregorio, San Mateo Co., V; Bradford, Lake Co., V; Mt. Tamalpais, Marin Co., VI; Willits, Mendocino Co., 17 VI; Cahto, 18 VI; betw. Cahto and coast, 22 VI; Westport, 19 VI. **1891** Oakland Hills, Alameda Co., 29 V; Leona (and Laundry Farm), n.d.; San Diego, VI; Tamalpais, 14 VI. **1892** South San Francisco, 9 IV; Petrified Forest, Napa Co., VIII; Hot Sprs., Lake Co., 21 VIII (with T.S.B.); Snow Mt., 22-25 VIII (with T.S.B.); Lagunitas, Marin Co., n.d.; Redwood Peak, Oakland Hills, Alameda Co., IX. There are very few coll. records of the trip of July, 1892, to Sequoia Mills, Mineral King, and Canyon of Kaweah R., with T. S. B. For fuller itinerary see his coll. localities given elsewhere. (From acount in Zoe (4:212) K. B. visited Bouldin Isl., Mokelumne R. sloughs, on 6-7 IX 1892; I have not seen colls. so dated.). **1893** Vanden sta., ?Solano Co., 30 IV; Collinsville, Solano Co., 30 IV; Mt. Tamalpais, Marin Co., VII; Bouldin Isl., Mokelumne R., Sacramento Co., 9 VII. (Sherman, Mormon, and Grand islands probably belong here though I have not found labels with yeardates and K. B. (Zoe 4:213) suggests there were no colls. made on these larger islands by this date.); San Jose del Cabo, L.C., IX; San Felipe, IX (with T.S.B. and Gustav Eisen to Cape region

only); Redondo, Los Angeles coast, X. **1894** Del Mar, San Diego Co., 28 III; San Felipe, e. San Diego Co., 2 IV; San Diego, 5 VI; Mission Valley, 6 VI; (Two one-day trips with T.S.B. to Romona). **1895** San Diego, III. **1896** Agua Caliente (present Palm Sprs., Riverside Co.), then San Diego Co., 10 IV (with T.S.B.); San Felipe, e. San Diego Co., 13 IV. (For fuller itinerary see the account under T.S.B. herewith). **1897** Point Loma, San Diego Bay, 25 IV. **1899** Masons, La Puerte Valley, San Diego Co., n.d.; San Felipe, V (with T. S. B..). **1901** San Diego Co., 1 IV; Vallecitos, 26 III (with T.S.B. q.v. for fuller itinerary); Elmira, Solano Co., 3 V; Castella, Shasta Co., 31 VIII. **1902** (One label for Snow Mt., 25 VIII, but this I believe an error for yeardate 1892 rather than 1902). **1903** San Diego, IV; hills just e. of Barstow, central Mohave Desert, V; Romona, X. **1905** Watermans, Barstow, central Mohave Desert, 15 V; Kramer, 15 V; Tehachapi, Kern Co., 15 V (obviously these cannot all properly bear same daydate); Caliente, 18 V; betw. Santa Rosa and Sebastopol, Sonoma Co., 8 VI; "along electric line near Santa Rosa," 8 VI; Colma, San Mateo Co., 14 VI; Port Costa, VI; hills above Fairfax, Marin Co., 18 VI; Ross Valley, slopes of Tamalpais, 18 VI; Bolinas road, 18 VI; near Lake Pilarcitos, 20 VI; 2-3 mi. inland from Bodega Bay, Sonoma Co., 26 VI; Lake Merced, San Francisco, VI; Rock Spr. trail, Tamalpais, 2 VII; Rodeo Lagoon, Contra Costa Co. or ? Marin Co., 11 VII; Los Gatos, Santa Cruz Co., 6 VII; Fresno, 21 VII; Exeter, Tulare Co., 23 VII; Three Rivers, 24 VII; Old Colony Mill, 5500 ft., 25 VII; betw. Redstone Park and Forest Gate, 26 VII; Cedar Creek, Giant Forest, 26 VII; Marble Fork of Kaweah, Giant Forest, 27 VII; Alta Mdws., 9000 ft., 1-8 VIII; Alta grade, Giant Forest Park, 8 VIII; Mt. Silliman, 11,188 ft. on 20 VIII, at 10,000 ft. on 22 VIII; Middle Fork of Kaweah, 24 VIII; San Vicente Rch., San Diego Co., 28 X; Stockton Rch. vic. Romona, X. The following localities fail to fit the foregoing sequences: Point Loma, San Diego Co., 28 IV; Del Mar, 11 V; Marine Hospital, San Francisco, V; hill betw. Alpine and Viejas, San Diego Co., 17 VI. ("Front and Redwood" refers to streets in San Diego city and may occur on labels unattended); Moss Beach, and cliffs above Halfmoon Bay, San Mateo Co., 20 VI. **1906** Romona, San Diego Co., 27 II; San Diego, III (First, Front, Redwood, Quince and Upas streets all appear on various labels); Tallys betw. Julian and Cuyamaca, V; Descanso, 16 VI; Viejas to Alpine, 16 VI; Lakeside, 23 VI; Romona, 14 VII; stage sta. above Romona, 15 VII; grade betw. Romona and Ballena, 15 VII; Cuyamaca, 16 VII; border of Cuyamaca Lake, 17 VII; Descanso grade, 19 VII; summits of hills e. of Del Mar, 5 VIII. **1907** Folsom, Sacramento Co., 8 V; ¼ mi. above American R. bridge, V; Pacific House, Eldorado Co., 19 mi. above Placerville, V (appears as simply Pacific on some maps); Simpsons Rch. on Sweetwater Creek, Eldorado Co., V; New York Ravine, 15 V; Blue Ravine, V; Camino, 7 mi. above Placerville, 22 V; "Sportsmans Hall, 5 mi. above Camino" same as 12 mi. above Placerville, 22 V; "Rocks, 20th milestone above Placerville, 23 V furtherest point reached); 15th milestone above Placerville, 24 V (on return); betw. Placerville and Camino, 25 V (on return); n. bank American R. above Lotus, 28 V; Lake Merced, San Francisco, 23 VI; cliffs betw. Bakers Beach and Lands End, 23 VI; Lands End, 23 VI; Bolinas Ridge of Tamalpais, 29 VI; Bolinas road near Libertys, to cliffs of seashore near Bolinas Bay, 30 VI; West Point road, Tamalpais, VII; banks betw. Martinez and Port Costa, Contra Costa Co., 4 VII; Port Costa, 4 VII; Tiburon, Marin Co., 7 VII; McDowell Ave. at Presidio, San Francisco, 11 VII; along rr. near Stockton, San Joaquin Co., 2 X. The following localities cannot be placed satisfactorily: Cuyamaca Lake, 17 VII (probable wrong yeardate); Judsonville and Marsh Creek, vic. Antioch, Contra Costa Co., 16 VI. **1908** Simpsons Rch., Sweetwater Creek, Eldorado Co., 1-2 VI; betw. Salmon Falls and Pilot Hill, VI; betw. Pilot Hill and Cool, 3 VI; Layne Rch. near Pilot Hill (K.B.'s girlhood home), n.d.; Magra sta., Placer Co., 5 VI; Cape Horn, 5 VI; betw. Cool and Auburn, 6 VI; Sportsmans Hall (i.e. Fyffe P.O..), Eldorado Co., n.d.; Presidio, San Francisco, 8 VI (does not fit well into this Sierra foothill sequence); betw. Castroville and Monterey, "119-120th mile which is betw. Bardins and Gigling sta., " (i.e. Marina), 16 VI; Rockspur, betw. Castroville and Monterey, Monterey Co., 16 VI; Seaside sta. near Del Monte, VI; cliffs of Pacific Grove, 17 VI; betw. King City and Jolon, 18 VI; Jolon, 19 VI; Valentine Isl., Tiburon, San Francisco Bay, Marin

Co., 3 VII; northside Point Isabel, 3 VII; Tocoloma, 5 VII; betw. Olema and Bolinas, 5 VII; grade betw. Larsens and Bolinas, 6 VII (Larsens is Ridgecrest of maps of today); Bolinas road, near bottom of grade from Larsens to Libertys, 6 VII; near Placerville, Eldorado Co., VII; "lava beds" about 4 mi. e. Placerville, VII; twelfth milestone above Placerville, VII; eighteenth milestone above P., VII; along rr. near Camino, 9 VII; Truckee, Nevada Co., VII; Donner, Summit Sta., 15 VII; n. side Lake Van Orden, between Donner and Cisco, VII; Cisco, 15 VII; Emigrant Gap, 16 VII; summit above Lake Valley, VII; Moss Beach, San Mateo Co., 26 VII; Montara Point, VIII; San Pedro, 17 mi. s. San Francisco, VIII; Farallon City, n.d.; Corbett rd. near Twin Peaks, S. F., VIII; betw. Bakers Beach and Lands End, S.F., VIII. **1909** Betw. Auburn and Cool, Eldorado Co., 28 IV; about 1 mi. from Folsom on road to Mormon Isl., Sacramento Co., 2 V; Bealville, Kern Co., n.d.; Tehachapi, V; Lancaster, V; Saugus, Los Angeles Co., V; Barstow, San Bernardino Co., n.d.; Casmalia, Santa Barbara Co., V; Antonio, betw. Casmalia and Surf, V; Surf, V; betw. Kings City, Monterey Co., and Jolon, 7 VI; Jolon, 8 VI; Nacimiento R., 9 VI; Burro tail, e. slope of Santa Lucia Mts., 9 VI; Gorda to Posts, 11 VI; Lucia, 12 VI; Plasketts Rch., 12 VI; Lucia, 14 VI; betw. Lucia and Littles Hot Sprs., 14 VI; Big Creek betw. Lucia and Slates Rch., coast Santa Lucia Mts., 14 VI; Sur R., VI; near New York Ravine, Eldorado Co., VI; localities which cannot be related to foregoing dates are: Descanso grade, San Diego Co., IV (probably wrong yeardate); Tiburon hills, Marin Co., V; Elmira, Solano Co., 3-4 V; Pope Valley grade, Napa Co., 1 VI. **1910** Toll House grade above Calistoga, Napa Co., 19 V; Mt. St. Helena (probably belongs here); Encinitas, San Diego Co., VI; Tighes Rch. betw. Romona and Santa Isabel (spelled Ysabel on old labels), VI; Santa Isabel to Julian, VI; Cuyamaca Lake, VI; Descanso, 16 VI; Viejas grade, 17 VI; Shaver Mills, Fresno Co., VI; betw. Ridge and Toll House, VI; cemetary near Toll House, VI; Volcano, Amador Co., VI; Fosters sta., 28 VI; Wylies sta., 30 VI (i.e. Cooks sta.); Ione, VI; Pope Valley, Napa Co., 26 VII; Aetna Sprs., 26 VII; Angwins, 27 VII; Elysian Park, Los Angeles city, 1 VIII (with Ernest Braunton, local horticulturist); Bixby, Los Angeles Co., 1 VIII; Clovis, Lake Co., 8 VIII; Bear Valley near Eppersons, 10 VIII; betw. Summit and Indian Valley, 10 VIII; Indian Valley, 3 mi. from Houghs Sprs., 10 VIII; Dorn Rch. near Leesville, 13 VIII; betw. West Point and Willow Camp, on seaward side of Mt. Tamalpais, Marin Co., 4 IX (Univ. Calif. Herb. exsiccata 142); Folsom, Sacramento Co., 24 IX; Simpson Rch., Eldorado Co., 24 IX; Sweetwater, betw. Simpsons Rch. and Salmon Falls, 24 IX; unplaced localities in this sequence are: Tiburon, Marin Co., VII; Caliente to Walkers Pass, VIII; Kramer, VI; Jolon, Monterey Co., 19 VII; Seaside sta. near Monterey, 20 VII. **1911** Barnwell, e. Mohave Desert, San Bernardino Co., 16 V; Hackberry Canyon near Caliente, Kern Co., n.d.; Caliente to Walkers Basin, VI; Kernville to Havilah, VI; Butts Canyon, Napa Co., 29 VI; Bottlerock Mt., Lake Co., 1-4 VII; Santa Margarita, San Luis Obispo Co., 12 VII; sand hills, Price Canyon, n.d.; hills back of Paso Robles, 12 VII; "Summit (Donner)," Nevada Co., 19 VII; Verdi, Washoe Co., Nev., 26 VII; Franktown, n.d.; Glenbrook, n.d.; summit above Glenbrook, n.d.; Portola, Plumas Co., Calif., 30-31 VII; probably Boca, Nevada Co., belongs to this last loop trip into Nevada; Pt. Pinos, Monterey Co., 6 VI; Langtry Rch. near Middletown, Lake Co., 16 VIII are isolated records. **1912** Price Canyon, near San Luis Obispo, n.d.; Morro, 30 IX; San Miguel, Monterey Co., 2 X. Bissell sta., 20 mi. se. Mojave, Kern Co., 16 VII has no accompanying record. It is not to be confused with Bisses sta., Tehachapi Mts., where W. R. Dudley botanized in June, 1895. **1913** Red Hill near Bishop, Inyo Co., V; Coldwater Canyon, n. of Southern Belle Mine, Mono Co., V; Riverton, Eldorado Co., n.d.; Boca, on Truckee R., 5525 ft., Nevada Co., VI; mdws. at foot of Peavine Mts., Washoe Co., Nev., 8 VI; Peavine foothills near Reno, 8 VI; Pyramid Lake, Nev., VI (with P. B. Kennedy); Sodaville, VII; Silver Canyon, e. of Laws, VII (with ? T.S.B..); betw. Bishop and Andrews Camp, "Bishop Creek Mts.," Inyo Co., VII (once appears as "Andersons Camp," a *lapsus graphicus* for Andrews Camp); Andrews Camp, above Bishop Creek, VII; Mammoth, 7900 ft., Mono Co., VII; Pine City above Mammoth, VII; near Lytle Creek, San Bernardino Valley, 15 VII (with S. B. Parish); Lake Merced, San Francisco, IX; Univ. Calif. Botanical Gar-

den, n.d. (weeds were closely watched as evidenced by several colls.). **1914** Kramer, San Bernardino Co., 15 V; near Daggett, V; Ord Mts., 19 V; Randsburg to Rand, Kern Co., V; Ellis Mdws., 8800 ft., n. Tulare Co., VII; Sage Mill Mdws., ? near Ellis Mdws., n.d.; Peckinpahs Rch., near Northfork, Madera Co., n.d.; Stevenson Creek, ? Eldorado Co., n.d.; Placerville, Eldorado Co., n.d.; Kyburz on American R., n.d.; Truckee, Nevada Co., n.d.; Riverton, Eldorado Co., VIII; Dugan, IX; San Joaquin bridge, Sacramento Co., 27 IX. **1915** Jean sta., Clark Co., Nev., V; Good Springs, V; Jean, VII; Cima, e. Mohave Desert, San Bernardino Co., Calif., VI. **1916** Coalinga to Parkfield, w. Fresno Co., V; canyon w. of Alcalde, V; Santa Catalina Isl., 17-25 V (see Millspaugh and Nuttall, Field Museum Publ. Bot. 5:27. 1923); West Point, near beginning of Rock Springs trail, Tamalpais, Marin Co., 9 VII. **1917** Cima, San Bernardino Co., 5 V; Moss Beach, San Mateo Co., 15 VII; Cisco, Eldorado Co., VIII. (At least once label noted reading Santa Catalina Isl. but this error for 1916). **1918** San Diego, 17 VI.

GAZETTEER FOR COLLECTIONS OF KATHARINE BRANDEGEE

(County designation follows the first comma; yeardate(s), the second)

(All place names are in California unless otherwise stated.)

Aetna Springs, Napa, 1910
Ager, Siskiyou, 1887
Agua Caliente (now Palm Springs), Riverside (formerly San Diego), 1896
Alcalde, Fresno, 1916
Allen Springs, Lake, 1884, 1886
Alpine, San Diego, 1905
Alta, Placer, 1889
Alta Grade, Tulare, 1905
Alta Meadows, Tulare, 1905
Amboy, San Bernardino, 1884
American River, Eldorado, 1907
Andersons Springs, Napa, 1884
Andersons Camp (error for next)
Andrews Camp, Inyo, 1913
Angel Isl., Marin, 1888
Antioch, Contra Costa, 1883, 1884, 1886, 1889, 1907
Antonio, Santa Barbara, 1909
Auburn, Placer, 1908

Bakers Beach, San Francisco, 1907, 1908
Bakersfield, Kern, 1884
Ballena, San Diego, 1906
Bardins, Monterey, 1908
Barnwell, San Bernardino, 1911
Barstow, San Bernardino, 1903,09
Bartlett Mt., Lake, 1884
Bealville, Kern, 1909
Bear Valley, now Lake, 1884,1910
Ben Lomond, Santa Cruz, 1889,90
Big Creek, Monterey, 1909
Big Trees, Santa Cruz, 1889
Bishop, Inyo, 1913
Bissell sta., Kern, 1912
Bixby, Los Angeles, 1910
Blue Canyon, Placer, 1888,89
Blue Ravine, Eldorado, 1907
Boca, Nevada, 1911,13
Bodega Bay, Sonoma, 1905
Boggs Lake, Lake, 1884
Bolinas Bay, Marin, 1907
Bolinas road, Marin, 1905,07,08
Borregos, San Diego, 1894
Bottleglass Mt., Lake, 1884
Bottlerock Mt., Lake, 1911
Bouldin Isl., San Joaquin, 1893
Bradford, Lake, 1890
Burbanks garden, Sonoma, 1908
Burro trail, Monterey, 1909
Butts Canyon, Napa, 1911

Cahto, Mendocino, 1890
Caliente, Kern, 1905,10,11
Calistoga, Napa, 1910
Camino, Eldorado, 1907,08
Cape Horn, Placer, 1908
Carbondale, Amador, 1886
Casmalia, Santa Barbara, 1909
Castella, Shasta, 1901
Castroville, Monterey, 1889, 1908
Cedar Creek, Tulare, 1905
Cemetary, Fresno, 1910
Cima, San Bernardino, 1915,17
Cisco, Eldorado, 1908,17
Clouds Rest, Mariposa, 1883
Clovis, Lake, 1910
Coalinga, Fresno, 1916
Cobb Mt., Napa, 1884
Coldstream, Lake, 1884
Coldwater Canyon, Mono, 1913
Collinsville, Solano, 1893
Colma, San Mateo, 1905
Colusa Jct., Colusa, 1889
Cool, Eldorado, 1908
Cooks sta., Amador, 1910
Corbett road, San Francisco, 1908
Cramer (see Kramer)
Cuyamaca, San Diego, 1906

Cuyamaca Lake, San Diego, 1906,07,10

Daggett, San Bernardino, 1914
Del Mar, San Diego, 1894, 1905, 06
Descanso, San Diego, 1906,09,10
Donner, Nevada, 1889,1908
Donner Lake, Nevada, 1883,88
Donner Park, Nevada, 1888
Dorn Rch., Lake, 1910
Dugan, San Joaquin, 1914

Edgewood, Siskiyou, 1887
Ellis Mdws., Tulare, 1914
Elmira, Solano, 1901,09
Elysian Park, Los Angeles, 1910
Emigrant Gap, Placer, 1908,10
Encinitas, San Diego, 1889,1910
Eppersons, Lake, 1884
Exeter, Tulare, 1905

Fairfax, Marin, 1905
Farallon City, San Mateo, 1908
Felton, Santa Cruz, 1889
Folsom, Sacramento, 1883,84,1907,09,10
Fosters sta., Amador, 1910
Franktown, Washoe, Nev., 1911
Fresno, Fresno, 1905
Front Street, San Diego, 1905
Fyffe, Eldorado, 1908

Gaviota, Santa Barbara, 1885
Geiger grade, Washoe, Nev., 1884,85
General Grant Grove, Tulare, 1905
Giant Forest, Tulare, 1905
Gigling sta., Monterey, 1908
Glenbrook, Douglas, Nev., 1911
Glen Ellen, Sonoma, 1908
Good Sprs., Clark, Nev., 1915
Gorda, Monterey, 1909
Grizzly Canyon, Lake, 1883

Hackberry Canyon, Kern, 1911
Halfmoon Bay, San Mateo, 1905
Hatchs Wharf, Santa Barbara, 1888
Hot Sprs., Lake, 1892
Hough Sprs., 1884
Howell Mt., Lake, 1888,89

Indian Valley, Lake, 1910
Indian Valley, Monterey, 1885
Ione, Amador, 1886,89,1910

Jean, Clark, Nev., 1915
Jolon, Monterey, 1908,09,10
Judsonville, Contra Costa, 1883,85,1907

Kaweah R. Canyon, Tulare, 1892
Keene sta., Kern, 1884
Kelsey, Lake, 1886
Kelsey Mt., Lake, 1884
Kernville, Kern, 1911
King City, Monterey, 1908,09
Kramer, San Bernardino, 1905,10,13,14
Kyburz, Eldorado, 1914

Lagunitas, Marin, 1888,92
Lake Merced, San Francisco, 1905,07,08, 13
Lake Pilarcitos, Marin, 1905
Lakeport, Lake, 1884,89
Lakeside, San Diego, 1906
Lake Valley, Eldorado, 1908
Lake Van Orden, Nevada, 1908
Lancaster, Los Angeles, 1884,87,1909
Lands End, San Francisco, 1907
Langtry Rch., Lake, 1911
La Puerte Valley, San Diego, 1889,99
Larsens, Marin, 1908
Lathrop, San Joaquin, 1907
Laundry Farm, Alameda, 1891
Lava Beds, Placer, 1908
Layne Rch., Eldorado, 1908
Leesville, Lake, 1910
Leona, Alameda, 1891
Libertys, Marin, 1890
Los Alamos, Santa Barbara, 1885
Los Gatos, Santa Cruz, 1905
Lotus, Eldorado, 1907
Lucia, Monterey, 1909
Littles Hot Springs, Monterey, 1909
Lytle Creek, San Bernardino, 1913

Magra sta., Placer, 1908
Mammoth, Mono, 1913
Marble Fork of Kaweah R., Tulare, 1905
Marina, Monterey, 1908
Marine Hospital, San Francisco, 1905
Marsh Creek, Contra Costa, 1907
Martinez, Contra Costa, 1892,1907
Masons, San Diego, 1889,99
Middle Fork of Kaweah R., Tulare, 1905
Middletown, Lake, 1911
Mill Valley, Marin, 1890
Mineral King, Tulare, 1892
Mission Valley, San Diego, 1894
Montara Point, San Mateo, 1908
Monterey, Monterey, 1889
Monticello, Santa Barbara, 1888
Morro, San Luis Obispo, 1912
Moss Beach, San Mateo, 1908,17
Mt. Diablo, Contra Costa, 1883,84
Mt. Eden, Alameda, 1890
Mt. Hannah, Lake, 1888
Mt. St. Helena, Napa, 1889,1910
Mt. Silliman, Tulare, 1905
Mt. Shasta (formerly Sissons), Siskiyou, 1887
Mt. Tamalpais, Marin, 1886,90,93

Newcastle, Placer, 1883
New York Ravine, Eldorado, 1907,09

Oakland Hills, Alameda, 1891
Old Colony Mill, Tulare Co., 1905
Olema, Marin, 1908
Ord Mts., San Bernardino, 1914

Pacific Grove, Monterey, 1908
Pacific House, Eldorado, 1907
Parkfield, Fresno, 1916
Paso Robles, San Luis Obispo, 1911
Peavine Mts., Washoe, Nev., 1913
Peckinpahs, Madera, 1914
Petrified Forest, Napa, 1892
Pilot Hill, Eldorado, 1908
Pine City, Inyo, 1913
Placerville, Eldorado, 1907,08,14
Plasketts, Monterey, 1909
Point Isabel, Marin, 1908
Point Loma, San Diego, 1897,1905
Point Pinos, Monterey, 1911
Point Sur, Monterey, 1888
Pope Valley grade, Napa, 1909,10
Port Costa, Contra Costa, 1905,07
Portola, Plumas, 1911,13
Posts, Monterey, 1909
Presidio, San Francisco, 1907,08
Price Canyon, San Luis Obispo, 1911,12
Pyramid Lake, Washoe, Nev., 1913

Ramona (see Romona)
Rand, Kern, 1914
Randsburg, Kern, 1914
Ravenna, Los Angeles, 1889
Red Hill, Inyo, 1913
Redondo, Los Angeles, 1893
Redstone Park, Tulare, 1905
Redwood City, San Mateo, 1889,92
Reno, Washoe, Nev., 1884,88
Ridge, Fresno, 1910
Riverton, Eldorado, 1913,14
Rock Springs, Marin, 1905
Rockspur, Monterey, 1908
Rodeo Lagoon, Marin or ? Contra Costa, 1905
Romona, San Diego, 1894,1903,06,10
Ross Valley, Marin, 1905
Roseville, Placer, 1884

Sage Mill, Tulare, 1914
Salinas R., Monterey, 1885
Salmon Falls, Eldorado, 1908
San Bruno Hills, San Francisco, 1908
San Buenaventura, Ventura, 1885
San Diego, San Diego, 1889,91,94,95, 1901,03,06,18
San Felipe, L. C., 1893
San Felipe, San Diego, 1894,96,99
San Francisco, San Francisco, 1889,1905, 07
San Gregorio, San Mateo, 1890
San Joaquin bridge, San Joaquin, 1907, 14
San Jose del Cabo, L. C., 1893
San Luis Obispo, San Luis Obispo, 1885
San Luis Rey, San Diego, 1885
San Marcos, Santa Barbara, 1889
San Miguel, San Luis Obispo, 1912
San Pedro, San Mateo, 1908
San Simeon, San Luis Obispo, 1888, 89
San Vicente Rch., San Diego, 1905
Santa Barbara, Santa Barbara, 1885,88, 89
Santa Catalina Isl., Los Angeles, 1889, 1916
Santa Cruz Mts., Santa Cruz, 1889
Santa Inez, Santa Barbara, 1889
Santa Isabel, San Diego, 1910
Santa Lucia Mts., Monterey, 1909
Santa Margarita, San Luis Obispo, 1911
Santa Rosa, Sonoma, 1905
Saugus, Los Angeles, 1909
Seaside, Monterey, 1908,10
Sebastopol, Sonoma, 1905
Sequoia Mills, Tulare, 1892
Silver Canyon, Inyo Co., 1913
Simpson Rch., Eldorado, 1907,08,10
Sissons (see Mt. Shasta)
Shaver Mills, Fresno, 1910
Slack Canyon, Monterey, 1885
Slates, Monterey, 1909
Snow Mt., Lake, 1892,1902
Sodaville, Mineral, Nev., 1913
South Dome, Mariposa, 1883
South Fork, Tulare Co., 1914
South San Francisco, San Mateo, 1892
Southern Belle Mine, Mono, 1913
Sportsmans Hall, Eldorado, 1907,08
Steamboat, Washoe, Nev., 1884
Stevenson Creek, San Joaquin, 1914
Stockton, San Joaquin, 1907
Stockton Rch., San Diego, 1905
Strongs Canyon, Nevada, 1884
Summit, Nevada, 1883,88,1911
Surf, Santa Barbara, 1909
Sur R., Monterey, 1909
Sweetwater, Eldorado, 1884,1910
Sweetwater Creek, Eldorado, 1883,1907, 08

Tallys, San Diego, 1906
Tamalpais, Marin, 1886,90,91,93,1905,07
Truckee, Nevada, 1888,1908,14
Tehachapi, Kern, 1884,89,1905,09
Three Rivers, Tulare, 1905
Tiburon, Marin, 1907,10
Tiburon Hills, Marin, 1909

Tocoloma, Marin, 1908
Toll House, Fresno, 1910
Toll House, Napa, 1910
Tracy, San Joaquin, 1889

Univ. Calif. Bot. Garden, Alameda, 1913

Valentine Isl., Marin, 1908
Vallecitos, San Diego, 1901
Valley Ford, Lake, 1886,87
Vanden sta., Solano, 1893
Ventura, Ventura, 1885
Verdi, Washoe, Nev., 1911
Viejas, San Diego, 1906,10
Volcano, Amador, 1886,1910

Walkers Pass, Kern, 1910
Watermans, San Bernardino, 1905
Westpoint, Marin, 1907,10,16
Westport, Mendocino, 1890
Willits, Mendocino, 1890
Willow Camp, Marin, 1910
Wylies sta., Amador, 1910

Yosemite Valley, Mariposa, 1883
Yucca, Kern, 1884

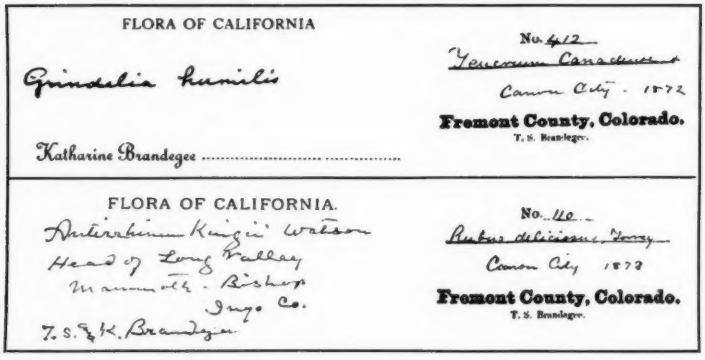

Fig. 1. (Upper left).—Label in handwriting of Katharine Brandegee. Fig. 2. (Lower left).—Label in handwriting of T. S. Brandegee in his advanced years. Fig. 3. (Right).—Two labels in the handwriting of T. S. Bandegee at the time of his residence in Colorado.

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PEATTIE, D. CULROSS. T. S. Brandegee. Dict. Am. Biog. **2**:599-600. 1929. Essentially a repetition of Setchell's biography, which see.

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UNIVERSITY OF COLORADO,
BOULDER, COLORADO.

Additions to the "Mammals of Indiana" *

Marcus Ward Lyon, Jr.

Page 42. *Sorex cinereus*, skull and feet in U.S.N.M. (No. 267310), collected in mouse trap at Lake James, Steuben Co.—West edge of St. Joseph Co. Jan., 1938, by George M. Stephenson in alc. in U.S.N.M. (No. 267516). Caught during fox chase.

Page 46. *Cryptotis parva*, Upland, Grant Co., autumn 1937, by William J. Tinkle, in alc. in U.S.N.M. (No. 267511).

Page 52. *Blarina brevicauda*, Delaware Co., albino skin in Ball State Teachers College. Leo I. Murray, Journ. Mamm., vol. 20, p. 501, Nov. 1939.

Page 79. *Lasiurus borealis*, specimen in alc. in U.S.N.M. (No. 269080), collected in Marion Co. by S. E. Perkins, III.—U.S.N.M. No 259817, Irvington, Marion Co., collected by W. P. Hay.

Page 83. A specimen of *Lasiurus cinereus* fell into Lake Maxinkuckee, Marshall Co. Taken out by S. E. Perkins, III of Indianapolis, died within an hour. Skin and skull saved by S.E.P. (U.S.N.M. No. 267370).

Page 97. *Procyon lotor lotor*, three skulls in U.S.N.M. (Nos. 261212, 261214, 261215), 1937, Wells Co.

Page 103. Lyon, Marcus Ward, Jr. The Least Weasel in St. Joseph County. Amer. Midl. Nat., vol. 22, p. 216, July 1939. Specimen in U.S.N.M. (No. 268510).—More Least Weasels in Indiana. Amer. Midl. Nat., vol. 23, p. 253, January 1940. One specimen in alc. from Pulaski Co. in U.S.N.M. (No. 259019). One specimen in alc. from Wells Co. in U.S.N.M. (No. 261013).

Page 108. *Mustela noveboracensis*, six skulls in U.S.N.M. (Nos. 261205-261210), 1937, Wells Co.

Page 112. *Mustela vison mink*, skull in U.S.N.M. (No. 260198), Jefferson Co.

Page 128. *Mephitis nigra*, six skulls in U.S.N.M. (Nos. 261187-261192), 1937, Wells Co.; two skulls in U.S.N.M. (Nos. 260196-260197), Jefferson Co.

Page 133. South Bend Tribune of July 9, 1936, mentions a badger killed at Argos, Marshall Co., by William Carl.—In the Evening News-Banner, Bluffton, Ind., Dec. 18, 1936, is a report of a badger caught near Huntington by Willard Burkhart. Skull in U.S.N.M. (No. 261098).—In the Evening News-Banner, Bluffton, Ind., Dec. 19, 1936, 16 lb. badger, 31 in. long, reported killed in Rockcreek Township.

Page 139. *Vulpes fulva*, two skulls in U.S.N.M. (Nos. 261185 and 261186), 1937, Wells Co.

Page 142. *Urocyon cinereoargenteus*, skull in U.S.N.M. (No. 261184), 1937, Wells Co.; skull in U.S.N.M. (No. 260195), Ripley Co.

Page 203. *Sciurus carolinensis carolinensis*, skull from Jefferson Co. in U.S.N.M. (No. 260199).

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* With few changes these additions to the "Mammals of Indiana" are taken from the author's personal copy and are herewith published posthumously. The editor is greatly indebted to Dr. Remington Kellogg, Division of Mammals, U. S. National Museum, and Dr. Frederick H. Test, Dept. of Zoology, University of Michigan, for assistance given in checking the specimens cited and in preparing these notes for publication.—Theo. Just.

Page 213. *Glaucomys volans volans*, skin and skull in U.S.N.M. (No. 261217), 1937, Marshall Co.

Page 238. *Peromyscus maniculatus bairdii*, specimens from Jefferson Co. collected in 1941 by Frederick H. Test in Museum of Zoology, University of Michigan. In lit., Oct. 18, 1941.

Page 240. *Peromyscus leucopus*, skin from near Bryantsburg, Jefferson Co. in U.S.N.M. (No. 260200).—Specimens from Harrison and Jefferson Cos. collected in 1941 by Frederick H. Test in Museum of Zoology, University of Michigan. In lit., Oct. 18, 1941.

Page 258. *Microtus ochrogaster*, specimens from Harrison and Jefferson Cos. collected in 1941 by Frederick H. Test in Museum of Zoology, University of Michigan. In lit., Oct. 18, 1941.

Page 269. *Ondatra zibethica zibethica*, skulls in U.S.N.M. (Nos. 261201, 261202), 1937, Wells Co.

Page 275. *Mus musculus*, specimens from Harrison, Jefferson and Parke Cos. collected in 1941 by Frederick H. Test in Museum of Zoology, University of Michigan. In lit., Oct. 18, 1941.

Page 281. *Napaeozapus* sp., specimen from Park Co. collected July 28, 1930 by P. F. Hickie, in Museum of Zoology, University of Michigan, (No. 65310), skin and skull, female. Frederick H. Test in lit., June 17, 1942.

Page 311. Mr. George Stephenson found fragments of deer antlers, two different individuals, in Highland Park Cemetery. Said he would place them with Northern Indiana Historical Society.

Page 314 bis. *Cervalces roosevelti*, probably post-glacial from Hazelton, Indiana. Edwin C. Galbreath, Journ. Mamm., vol. 20, p. 508, Nov. 1939.

Page 315. After first paragraph insert *Cervalces illinoensis*. An antler fragment was found in White River, about 30 miles from mouth (Daviess Co.) by Oscar Main of Oakland City. In lit. dated March 3, 1936 he says it was so identified by Dr. E. S. Riggs of the Field Museum of Natural History, also that he gave the specimen to the Field Museum (No. P15143). See Elmer S. Riggs, Amer. Midl. Nat., vol. 17, p. 664, May 1936.—Cranium of moose, *Cervalces*, found in marl in ditch digging near North Liberty, summer of 1937. Now in U.S.N.M. (No. 15494, Vert. Palaeont.). Only known record for State, but moose remains said to be fairly common in Big Bone Lick, Ky. Recorded by C. Lewis Gazin, Amer. Midl. Nat., vol. 19, pp. 740-741, fig. May 1938.

Page 329. A very fine *Symbos* skull in U.S.N.M. (No. 14428, Vert. Palaeont.) was found in a branch of Mill Creek by Victor F. Mahan, July 12, 1936. It was lying in the clayey creek bed which is about 5 ft. below the level of the surrounding flat country, Ripley township, Montgomery Co. on Ed. Hedrick farm, about 12 miles s.w. of Crawfordsville. Popular account in South Bend Tribune, Sunday, August 16, 1936. For measurements, etc., plates, see Lyon, Marcus Ward, Jr. and Fred T. Hall, Amer. Midl. Nat., vol. 18, pp. 608-611, July 1937.—*Symbos* skull found by Dr. Wm. Bebb near Spencer, Owen Co., 1936.

Page 338. Henry Duncker's remains of animals bought on his death by Fred Rensberger of Lakeville, Indiana, March, 1937.

Page 340. Portions of *Mastodon* in U.S.N.M., (Nos. 8881 and 8882) from Kosciusko Co. (Winona Lake).—*Mastodon* remains found at Romney, Montgomery Co., in 1930's.

Page 348. Mammoth tooth from farm of R. B. Thompson, Adams Township, Hamilton Co., 7 mi. n.e. of Sheridan, 1¾ mi. off national 31, in Muncie State Normal, photographs in possession of M. W. Lyon, Jr.

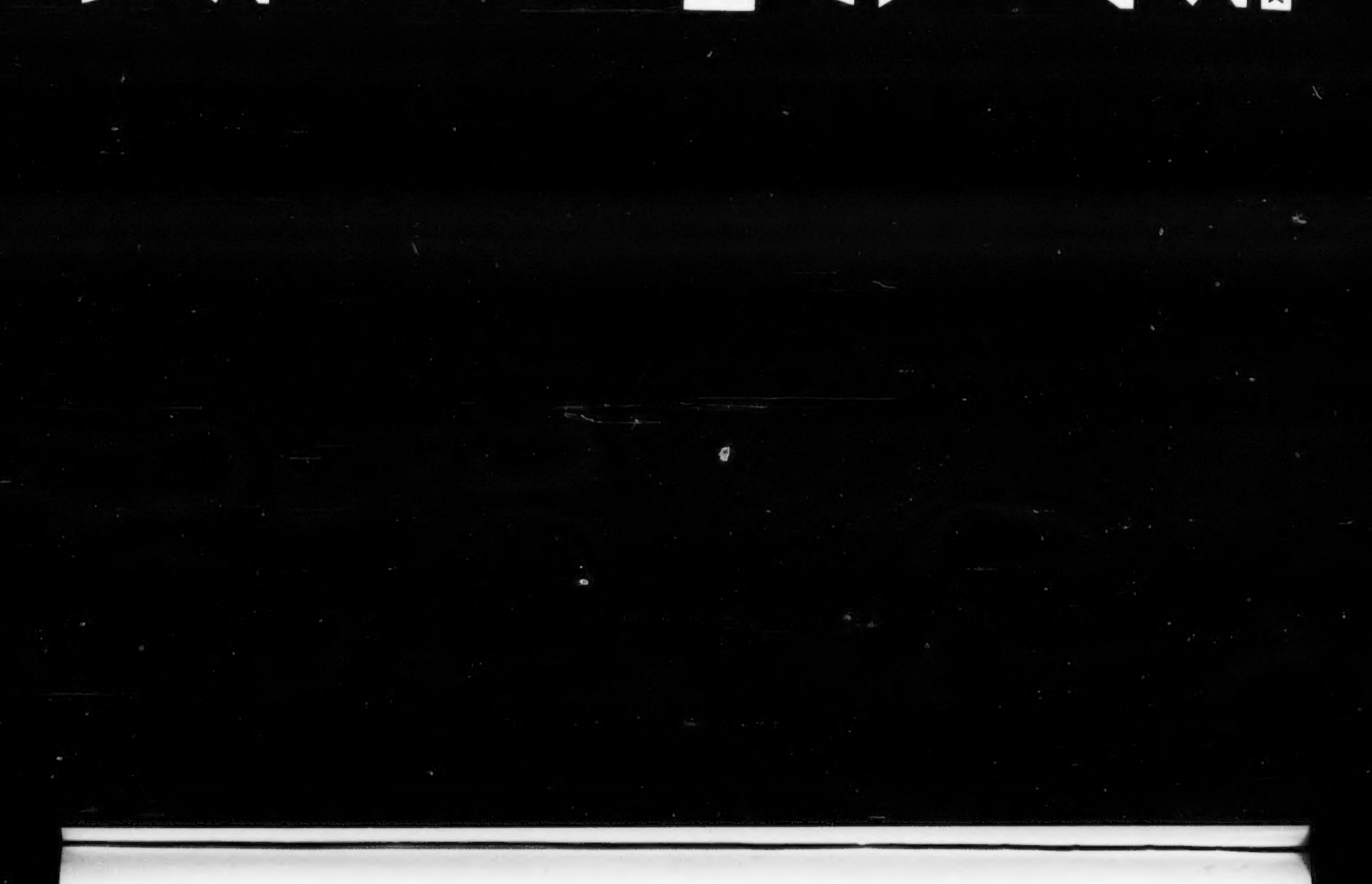
Book Review

PLANT HUNTERS IN THE ANDES. By T. Harper Goodspeed. Farrar & Rinehart, Inc., New York. 1941. xvi + 429 pp., illustrated with photographs. $5.00.

It has always seemed to me that one must be courageous indeed to write a book on one's travels; only to attempt a reply to the inevitable question that starts: "Do tell us all about. . . .," with which any and all friends meet one on return, is to discover what one really is "in for." That Professor Goodspeed, renowned as a scientist but not professionally a writer, has accepted the challenge and told us "all about" not only his own but the travels of ten other botanists, these usually scattered over territory extending from northern Peru to Patagonia in 1935-36 and 1938-39, and dared to do it, is further evidence, if any were needed, that he will make any effort to interest others in plant exploration, exploration that is for the benefit of his fellow men. That this interest will be awakened in any reader who follows him beyond chapter 1 (which can be skipped until curiosity impels its perusal) there is no doubt, for there is many a successful travel book that is less continuously absorbing, less rich in human interest and humorous anecdote or less effective in giving information; much of the last is of general interest, without being dull or trite. Often, or perhaps usually is the word, the author has gained reader-interest, at least in part, by not being afraid to be personal, even very personal, in describing the experiences of himself and Mrs. Goodspeed; but there are pages without number, particularly in the portions which he has written from first-hand knowledge, that carry one along oblivious to everything but the thought, the continuity is so well maintained and the expression so well-chosen and spontaneous. Unfortunately for the homogeneity of his work, however, the author was compelled, evidently in desiring to present the history and the purpose of the explorations he directed (explorations primarily initiated for the discovery of species of tobacco, and for the collection of their seeds) to attempt the weaving of the itineraries of all his coworkers into one "travel." This, in spite of the clever devise of treating the participants as characters (known by their first names) and by quoting (and less happily sometimes reworking) their apparently adequate diaries, has resulted in a certain lack of uniformity. To many a reader, therefore, botanist or not, there will be some paragraphs if not pages that he will wish to shorten if not delete in a work which after all purports to be, at least from the title, a history about plant hunters; and to the student of social science there is a chapter or two that may make him feel that his own field has been, for such a work, too seriously explored, however creditably and entertainingly the many botanical ones.

But this very fact emphasizes the richness of the work; there are over 420 pages in which scarcely a phase of life in the Andes, from tropics to desert and perpetual snow, is not somehow touched upon; an index to 400 or more items will assure the book's popularity as a ready reference volume for years to come. The routes of the expeditions are shown on maps and a hundred and twenty odd photographs, as beautiful as the pointed captions are interesting, stimulate, if that is ever needed, the reader's awakened imagination.

To forget your present troubles join Professor Goodspeed and his intrepid and capable plant hunters in their exciting adventures for months on end from Robinson Crusoe's Isle to Amazon jungle and Inca ruins; the author's sympathetic and friendly book should increase understanding between nations and should contribute much to an appreciation in all America of *why* plant hunters *are*, and must be supported in their often difficult work for the benefit of us all.—J. FRANCIS MACBRIDE, Field Museum of Natural History.



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Founded by J. A. Nieuwland, C.S.C.

Contents

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